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DIAMOND MINING IN SOUTH AFRICA.

By George D. Stonestreet, M. Am. Inst. M. E.

DIAMONDS have been found in nearly every country of the globe, but the discovery of these precious stones in Southern Africa so far exceeded those of Brazil and India that a brief account of the difference in the formations in which they were found and the methods of mining and concentration there might prove interesting.

In India and in the Brazilian diamond fields diamonds are found in the alluvial deposits of rivers both ancient and modern, and far from the source of their origin. The true geological home of the diamond (improperly called the matrix) has never been discovered and, consequently, a mine properly so-called, does not exist as far as we know. But the Diamond Mines of Africa probably come as near being actual mines as will ever be found, although the diamonds found there are not in position to-day where they were formed; a condition that will be discussed later when speaking of crystalization.

The Diamond Mines of South Africa are situated in the

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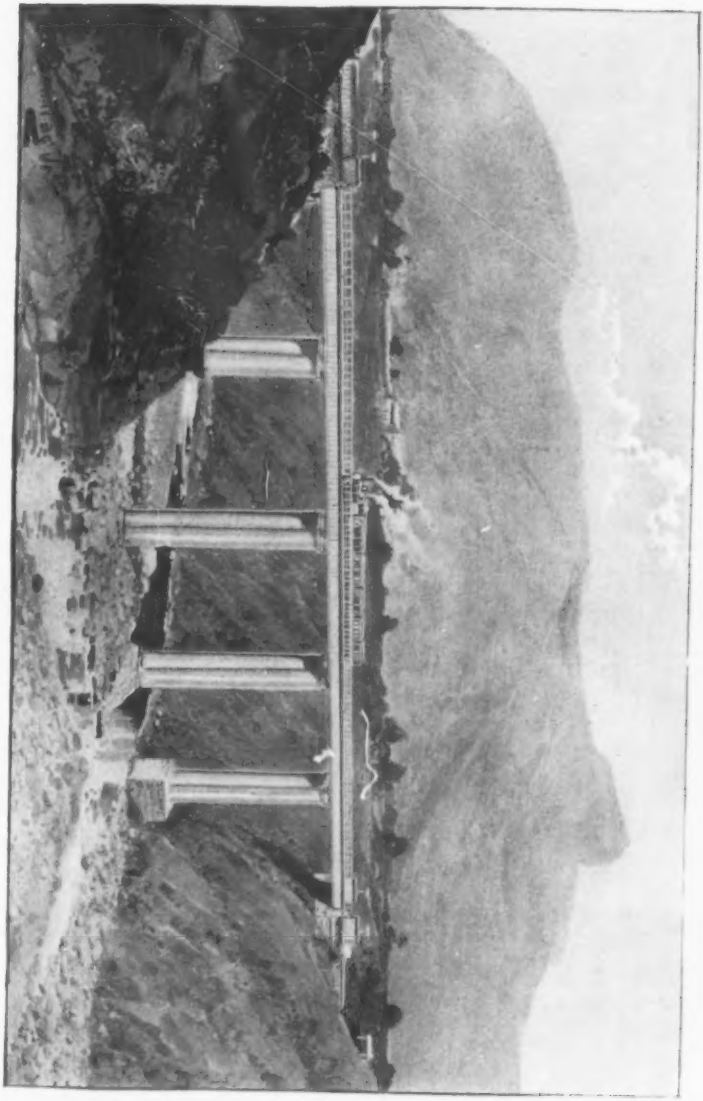
British Province of Griqualand West, at a distance from the nearest coast of about 600 miles. The country there is an elevated plateau over 4000 feet above sea level, and in the vicinity of the mines it is quite flat, dry and treeless. About 25 miles to the north of the mines is the Vaal River where the first diamond discoveries were made, and which now is the source of the water supply for mining and city uses.

There are four mines, the Kimberley, De Beers, Du Toits Pan, and Bultfontein, given in the order of their value and importance. They are all within a radius of two miles from the De Beers mine, and there is every reason to think that they are connected at a remote depth, because the peculiar "pipe" or chimney formation of each mine has been clearly shown down to a depth of over 600 feet, and the walls of the mines trend towards the central one.

From the surface indications it was difficult to determine the geology of the country, and had it not been for the accidental find of diamonds on the surface soil there was nothing to indicate any peculiar diamond bearing formation. The surface soil was a hard red clay for about ten feet down, and beneath this, after the mines were opened, was found the measures of the sub-carboniferous which extended down to the depth of 295 feet. Beneath these measures an unstratified basaltic rock was found which would be better classed as an amygdaloidal dolerite with much agate distributed through it. When the mines were well opened it became easy to observe the uptilted strata of the sub-carboniferous measures, which were tilted all around the mines as if an upheaval had occurred from one central point. This was true of each mine and is exactly what has taken place, for through the hard dolerite and the even measures above it and from some unknown source, nature in some gigantic throe forced up these four pipes as vents of safety a strange material which contained the diamonds. If any overflow of this eruption occurred no signs of it exist now, but the overflow may have been washed away by storms into the valley of the Vaal River and thus accounted for the presence of diamonds there. It is also probable that similar mines exist elsewhere, and, perhaps, in Brazil and India they may yet be found. The foreign material forced up, as described, was called "blue" by the miners on account of its color, and is now known to consist of a hydrous magnesian conglomerate with silica as a base, and contains nearly all the chemical elements known. Large, detached boulders of dolerite also occur in the "blue" which decompose rapidly in scales on ex-



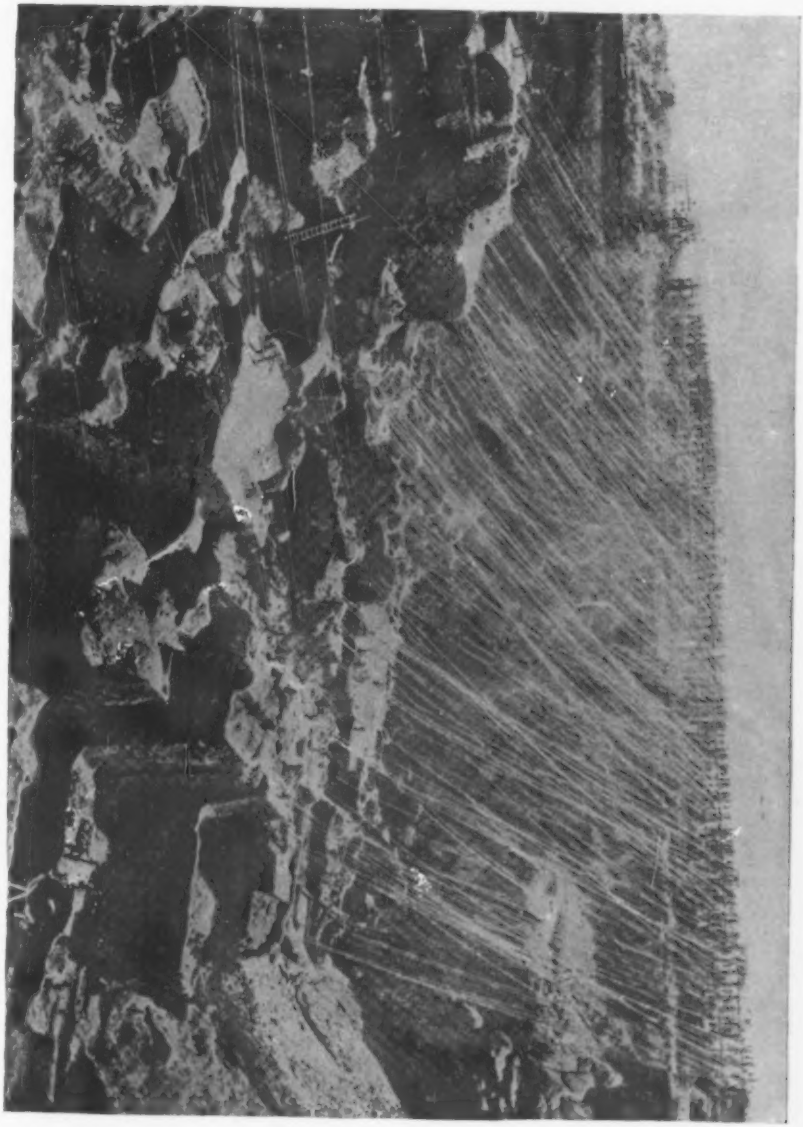
BRIDGE ON THE RAILWAY TO KIMBERLEY.

posure to the atmosphere, clearly evidencing the action of fire of great intensity, and as if to strangely contradict the volcanic origin of the mines, pebbles of agate, etc., plainly water-worn are found side by side with pieces of charred wood and other organic matter, showing plain evidence of heat. At a depth of over 300 feet a section of a tree nearly destroyed by fire was found and of unknown variety. As the Kimberley mine was the richest it has been most worked, and a description of this mine would apply to the others. When first opened this mine had an area on the surface of about 14 acres, and diamonds were found only within this area. Beyond the well-defined limits of the mine the black shales of the sub-carboniferous era occur, and as the mines were opened deeper this material fell in and greatly hindered the progress of mining. This shale was called by the miners "reef." The reef continued to assume an angle of rest until the original surface area had been increased to 30 acres when a depth of 650 feet had been reached in the mine. Had this been better understood in the first instance different methods of mining would have been followed, and the mine which was worked on the open quarry plan would have been worked, as it is now made compulsory to do, by outside shafts and headings as shown in the section illustrated. The mine was first opened in 1871, and by 1883 the amount of material actually taken out was over 20 million tons, which yielded 17½ million carats of diamonds, which were sold for over 90 million dollars.

By calculation of the amount of diamond bearing ground removed from each of the four mines to date, and from the known average yield per ton in each, it is found that not less than 33 million carats of diamonds (or more than 6½ tons weight) have been extracted from the four mines, realizing over 40 millions sterling, or, about 200 million dollars. This enormous quantity of gems have gone to swell the world's supply for the purposes of luxury in taste, primarily, and a small proportion for use in the mechanical arts and for scientific needs.

To the great Kimberley mine, however, belongs the palm of wealth and an account of fortunes made by its owners would read like a romance of the Arabian Nights.

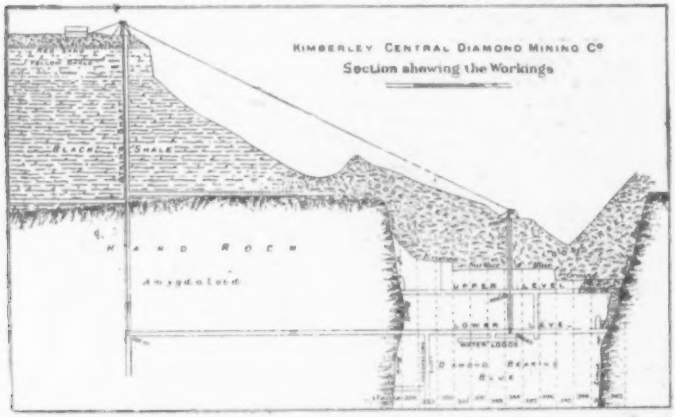
No pen can adequately describe the appearance of the Kimberley mine. It is the largest hole made by man, and in the shortest space of time, for the incentive to work was there—the diamond. A spectator standing on the edge looks down and sees men at work looking like ants in size, and during the blasting hours he can in



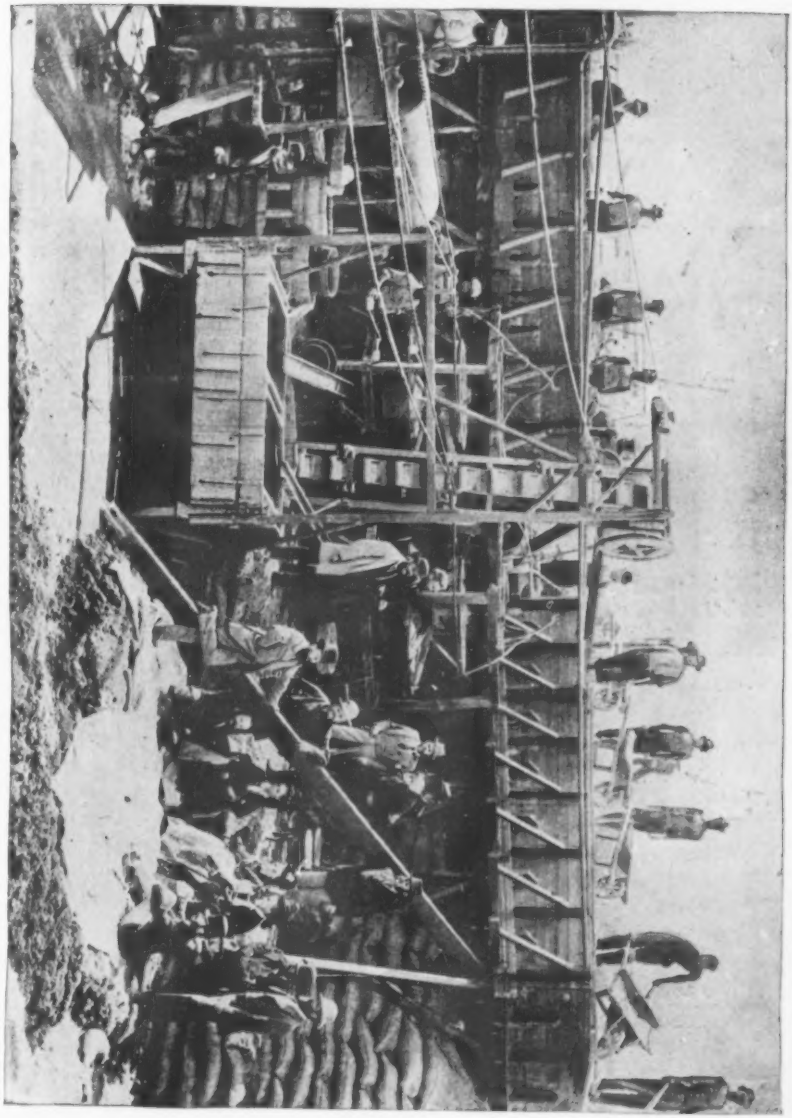
SOUTH SIDE OF THE KIMBERLEY DIAMOND MINE, SHOWING WIRES CONNECTING CLAIMS WITH ORIGINAL SURFACE LEVEL.

perfect safety witness the explosion of thousands of pounds of dynamite and note the rending of masses of blue and rock, which would fall far below him. As an honor to the late "Chinese Gordon" when he visited the mines, the writer saw the Kimberley mine illuminated at night with thousands of improvised lamps assisted with colored fires and displays of fireworks. The weird effect produced was grand, for the eye could not properly measure distance at night, and the twinkling lamps but served to heighten the effect.

The machinery at first used was simple, first, carts and then rawhide ropes with leather buckets. The ropes were stretched from the edge of the mine into the owner's claim of 30 feet square, and the countless number of these ropes made a most singular appearance and caused great confusion. The buckets were hung on a traveller



having grooved wheels, and was drawn to the edge with a lighter rope. This method answered for the first 100 feet, and gave a production per claim of about 5 tons daily. This being all dry, or hand sorted, was sufficient until the "rocker" was introduced and water used for concentration, and, it then became necessary to improve the hoisting machinery, and steel wire rope and iron tubs were used. This was finally so improved that 1200 tons daily was a fair day's work. Steel tubs holding a ton, mounted on trunnions, in a carriage having four grooved wheels and running on two parallel wire ropes, automatically filled and dumped themselves. If the reader is in need of a new sensation he should take a trip up or down into the mine on one of these tubs. Imagine yourself being



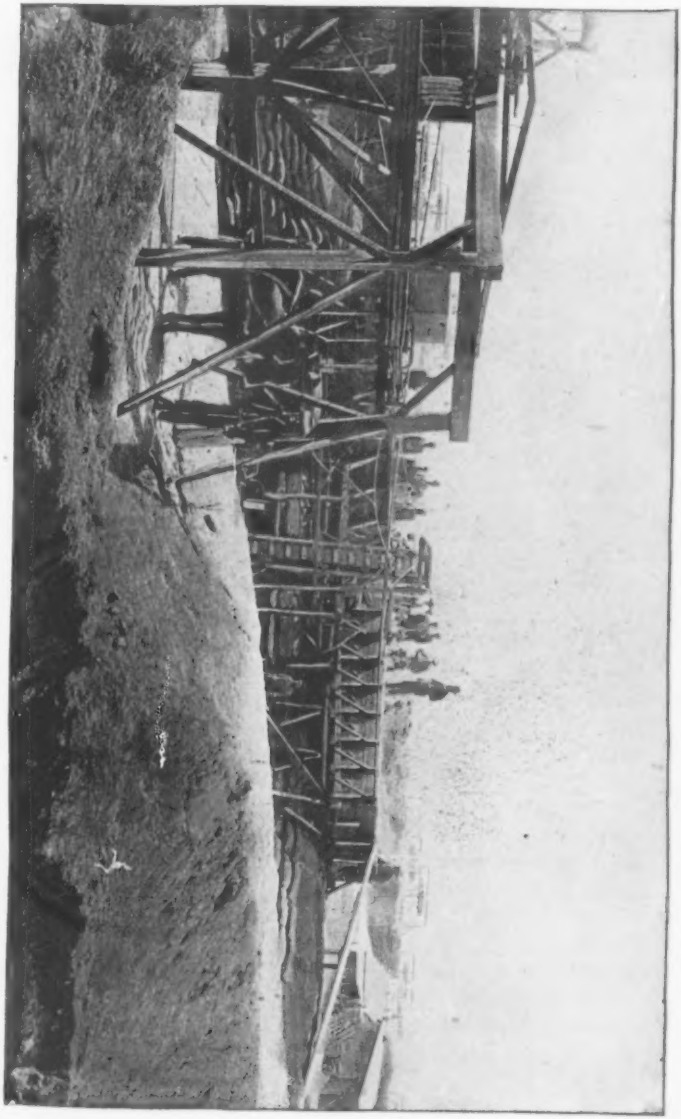
THE FIRST DIAMOND CONCENTRATING PLANT; CAPACITY 100 TONS DAILY.

whisked up by the irresistible power of steam on a pair of slender wires, with a clear drop below you of 600 feet, with the chances of the tub leaving the swaying wires very good, and you will probably decline the trip.

The concentrating machinery was now improved to keep pace with the mining, and the rocker gave place to a circular machine of 8 or 10 feet in diameter, which consisted of an annular trough, in which knives or stirrers were revolved to assist in settling the heavy gravel and to help throw off the light material. The heavy gravel which fell to the bottom was removed once a day, and, after being cleaned in water, was carefully sorted for the diamonds it invariably held. The blue when first mined was of course impossible of concentration, and it had to be taken from the mine in cars on a narrow gauge railway outside the town, and spread over floors until the rain, air and sun had thoroughly decomposed it; which effect required from six to twelve months. The blue was then picked up and carried in cars on rails to the concentrators, where 1500 tons were daily put through them, thereby reducing the labor of search through this large amount of material down to about a half ton. Many trials were made to reduce the blue at once, but the practical mechanic will soon see why they failed when the conditions are appreciated. The blue was hard and contained diamonds varying in size from dust to that of a hen's egg, and the diamond being brittle no rolls or stamps could be used.

The exposure of so much blue on the floors was the cause of much loss by theft by the native labor and others walking over the floors. Even the chickens did their proportion of stealing by picking up the small glittering stones to aid digestion in their crops. Most chickens, when executed for their crimes and served at table, paid the expenses of their previous maintenance when the cook searched their innermost recesses. The chickens were adjudged guilty first and tried afterwards, but the natives seldom gave a chance to have either done to them, because of their great cunning. It is calculated that fully 25 per cent. of the diamonds were stolen by the natives in spite of the most stringent laws and of searching them carefully twice a day. Now and again they would be caught and the choice given them of a good threshing or ten years' penal servitude. They generally chose the first, but it did not act as a deterrent.

The following is an abridged profit and loss account of a mining company for the year ending November 30, 1885:



METHOD OF DRIVING CONCENTRATING MACHINERY.

Dr.	£	*s.*	*d.*
To wages, salaries, etc.	49,481	10	0
" fuel and water	10,930	0	6
" explosives	3,673	17	1
" feed and stables	3,523	1	9
" material for maintenance and stores	5,242	6	3
" licenses and expenses	3,655	2	4
" balance of profit	78,802	13	6
	£155,308	8	5

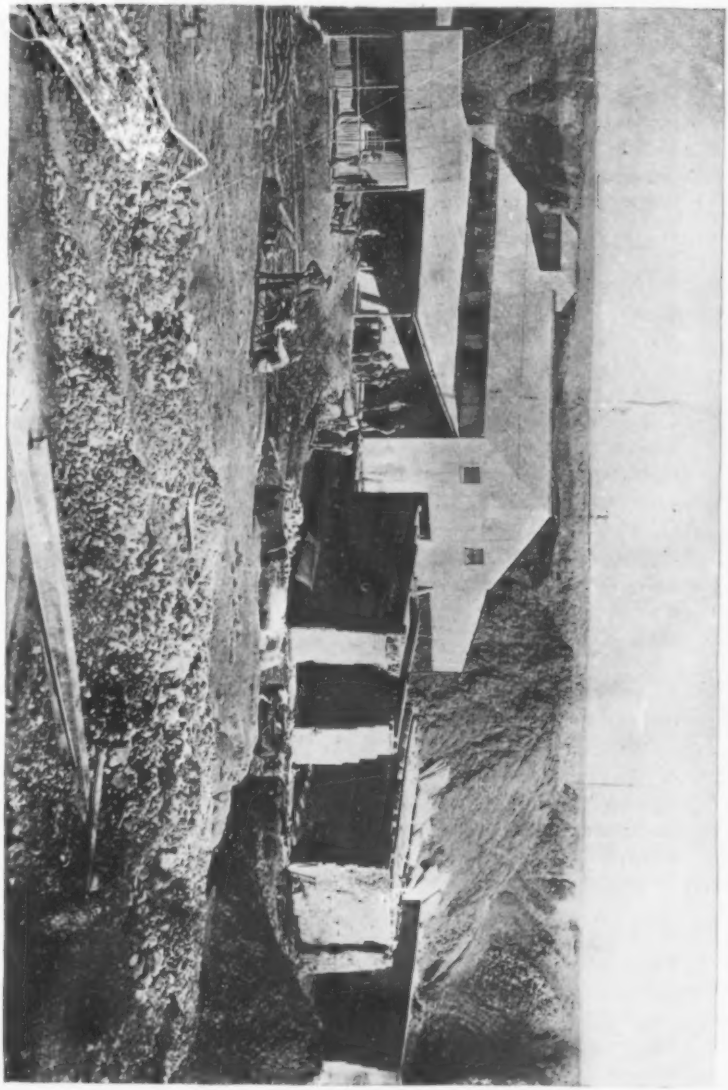
	£	*s.*	*Cr.* *d.*
By diamond account 135,684 carats@19/2¾	130,466	5	9
" debris sold, etc.	880	19	3
" hauling out for other companies	1,977	15	6
" hauling out water, 2,325,296 gallons	1,442	7	11
" hauling out blue on floors, 41,082 tons@10/.	25,541	0	0
	£155,308	8	5

The preceding account represents the cost and profit resulting from the washing 88,185 tons of blue ground, which yielded 1.54 carats per ton, realizing 19/2¾ per carat, so that, the value of the ground per ton was 29/7 (about $\$7\frac{25}{100}$).

The expenses also include the hauling out of 125,021 tons of "reef" or non diamond yielding material, which fell into and stopped mining until it was removed. So that the actual profit of working one ton of ground was about $4.50. As an instance of profitable working in the De Beers Mine, one company with a paid in capital of £100,000 started work in 1884, and in the same year paid over 30 per cent. in dividends to its stockholders. Another after five years' work in the same mine paid back two-thirds of its capital of £500,000 to its stockholders in dividends.

The quality of diamonds found in the Kimberley and De Beers mines is similar, the color being better in Kimberley but the size larger in De Beers. The value of a diamond depends on the purity of its color, its freedom from flaws and spots, and its relative size. The finest the writer saw was found in Kimberley—the famous "Porter Rhodes," on the 12th of February 1880. It was a pure white octahedron, weighing 151 carats and was valued at £60,000. Mr. Rhodes carried this stone in his pocket with his loose change for over a year, so careless did men become with the association with wealth in such a concentrated form.

The labor was good and abundant, for the natives found there are stalwart, well muscled men, all warriors in their own tribe. A



THE KIMBERLEY BRICK WORKS. BANKS OF "REEF" IN THE REAR.

native's ambition was to acquire means for the purchase of cattle, which in his own territory he could barter for wives, and, after acquiring four or five dusky damsels, he would never work again, but live in idleness and allow his wives to work for him. His wages at the mines would average about one dollar per day, combining which with his ill-gotten gains by theft he would speedily become wealthy in his plurality of spouses. Bad as it might have been in some respects, there was, perhaps, no better factor in the civilization of this end of the Dark Continent than these diamond mines; for thousands after thousands of the natives would visit the mines for work and come into contact with white men and their ways, and every native would return to his own country improved, more than by any other means, in some degree and never cease talking of the white race to their brethren at home.

Many popular errors exist about diamonds, such as a belief in their shining in the dark, etc. A pure diamond, when properly cut and polished, is the most perfect refractor of light, its color having nothing to do with this quality. It must have light in order to refract light,—there is absolutely nothing phosphorescent about the diamond.

Then again it is the hardest of known substances, only another diamond can mark its surface; consequently, this is the only infallible test of its genuineness. Many diamond dealers sell African diamonds at an enchanced price to the uninitiated public as "old mine stones," presumably from Brazil or India. There is no difference whatever between them, because, a diamond being pure carbon, can be nothing more nor less than diamond, and is just as good, no matter where it is found. Great variations in color and purity of course exist, but it is not fair to the African mines to assume that all the best come from Brazil and India. In value a diamond is worth precisely what you can get for it, and this price is increased or diminished by its color, purity, or freedom from flaws, and its cutting. Some of the best cutting and polishing is now being done in New York and London; Amsterdam long ago lost her prestige for cutting.

The crystalization of the diamond is octahedron or eight sided, but, in the African mines many multiples of this crystal were found, where the writer has seen as many as thirty diamonds all fused together. These masses of diamonds were quite common, but sometimes a piece only of one diamond would be found, evidently fractured in the process of upheaval, and often, these pieces would

show evidence of fire after fracture. In the African mines great variety of color was found, oftenest yellow being the color, but white, blue, green, red and black diamonds were found in the order of their rarity.

A railway now extends from Cape Town to Kimberley and a journey there can be made with speed and comfort, and to the man of leisure a trip to the mines would prove an interesting one and, far out of the beaten paths of travel, with the prospect of good hunting a few miles north of the mines.

Note:—LORD RANDOLPH CHURCHILL, who is at present making research into the resources of South Africa, has recently written a letter to the New York *Herald* in which the Kimberley mine is discussed. We append from it a few paragraphs, pertinent and of interest.—EDITOR.

In the working of the mines there are employed about thirteen hundred Europeans and fifty-seven hundred natives. The wages paid range high, and figures concerning them may interest the English artisan. Mechanics and engine drivers receive from £6 to £7 per week, miners from £5 to £6, guards and tallymen from £4 to £5; natives in the underground works are paid from four shillings to five shillings per day. In the work on the "floors," which is all surface work, overseers receive from £3 12s. to £4 2s., machine men and assorters receive from £5 to £6, and ordinary native laborers from seventeen shillings sixpence to twenty-one shillings per week. In addition every employé on the "floors" has a percentage on the value of diamonds found by himself, the white employé receiving one shilling sixpence, and the natives threepence per carat. Nearly double these amounts are paid for stones found in the mines.

Another machine called the "pulsator" then separates the stuff, which appears to be a mass of blue and dark colored pebbles of all shapes, into four different sizes, which then pass on to the assorters. The assorting is done on tables, first while wet by white men, and then when dry by natives. The assorters work with a kind of trowel, and their accuracy in detecting and separating the diamonds from the eight different kinds of mineral formation which reaches them is almost unerring.

WHY THE STATES SHOULD NOT OWN THE RAILROADS.

By Benjamin Reece, C. E.

IN the demand for remedial legislation to correct the real or alleged evils of railway management, the polarization of interests is evidenced by the fact that the prescribed remedies very generally come from those having no experience in the practical details of railway operation, while those engaged in the direction of railroad properties vehemently declare that the evils complained of are not such as fall within the province of legislative interference or control.

The watchful interest of railway managers regarding crop reports and industrial probabilities show the very life of railways to be dependent on the yield of our farms, the output of our mines, and the activity of our shops. Upon the other hand, the many laws favoring the construction of railways, the enormous land grants, popular subscriptions and self-imposed taxes which from time to time have been awarded to the builders of railroads, as clearly demonstrate how intimately a country's prosperity is connected with its means and methods of transportation. That interests so mutually dependent should assume an attitude of open hostility, is proof that legislation is already attempting an artificial balance by which it is hoped to secure a static equilibrium of forces in counter action; but this can only be accomplished at the expense of those normal adjustments which if unobstructed would result in a healthy development on the lines of progressive interaction.

A recognition of the abuses and contentions arising from the management of our railways as now constituted, has given rise to discussions in which have been expressed every shade of opinion, from the ultra declaration that legislators have neither the moral right or the legal authority to interfere with capital as invested in our railroads, to the no less radical demand that individual and corporate holdings must cease and that railway ownership and control shall be vested in the national government.

The limits of a magazine article will not suffice to examine ever so briefly even a fraction of the numerous schemes which have been

suggested for the correction of existing evils and abuses in railway management. This article will therefore be confined to an examination of the practicability of the proposed ownership of the *road beds* by the several States, as advocated in an article entitled: "Should the States Own the Railroads?" which appeared in the May number of THE ENGINEERING MAGAZINE.

The author of the article in question declares that "the objections to the ownership and management of the transportation business of the country by the Federal Government are numerous and well founded," and he distinctly states that the Government has not and ought not to have the constitutional power to engage in any such business; but it is urged that these objections do not apply to the State ownership of these highways, open to all under proper conditions and operated by private enterprise."

Briefly stated it is proposed by that writer to give to the several States absolute control of the railroad tracks within their boundaries, together with the management of the traffic so far as the despatching and inspection of trains is concerned. The necessary equipment and motive power and the commercial departments of our railways are to be provided and managed by the individual shippers, or by any and all companies desiring to engage in transportation.

By frequent allusions to turnpikes, canals and the conduct of ocean travel, this proposed scheme appears to assume the proportions of a complete and logical solution of a very intricate problem. But eventhe most artificial examination of the question will suffice to show that while our turnpikes, canals and waterways bear some commercial resemblance to the railway, that in their physical aspect and modes of operation they are entirely different.

The fallacy rests in assuming that a similarity of mechanical operation is derived because of the commercial resemblance or agreement of the different forms of transportation.

In the operation of turnpikes the motive power is controlled by the owner of the vessel or conveyance, the movements of each is independent of the other, the vessel or conveyance may be mechanically adapted to, but is in no sense united to or forms any part of, the passage or roadways. The safety of each depends upon the same ordinary skill and watchfulness which a pedestrian exercises to avoid collisions when walking upon an ordinary thoroughfare.

The requirements of the traffic and the difficulties which beset

the management of our railroads, are of an entirely different character and infinitely more complicated. The moving train must have the absolute right to the position it occupies upon the track, and its rights must be known and respected by all who are in any way connected with the movement of trains,—thus the movement of each train is more or less dependent on that of every other train on the division, which must be operated as a unit. When it is remembered that the regular trains are classified and are run at high and varying rates of speed, the rights of each train being determined according to its class, in order to facilitate the safe and prompt movement of all; and that in addition, special and irregular trains are in constant service for the repairs of the line and other purposes, it will not be wondered at that on our trunk lines the rules governing those engaged in the movement of trains number several hundred, embracing many thousand words and are intended to provide for every possible contingency which may arise to trains upon the line, including delays, break-downs, failure of telegraph lines, etc. In order to prevent accidents and reduce delays to a minimum, the rules must be thoroughly understood, accurately followed, and implicitly obeyed by all. In addition to this each line has its own physical features, such as grades, curves, tunnels, railroad crossings, junction points, swing bridges, and dangerous highway crossings. These must be known to the men in charge of trains so as to avoid the breaking of trains in two, to insure making the proper stops, and to be familiar with such points as require the trains to be kept under easy control; in a word, this thorough knowledge of a road by those engaged in running its trains, is essential to safety and to prevent delay.

Recent accidents recorded in the daily press will serve to show that in spite of the most watchful precautions upon the part of the managers, very disastrous accidents are liable to occur. Is it not evident that in addition to the possession of the track, and the control of the vast army of track laborers, bridge builders, etc., the State would be compelled to assume the control of engine-men and trainmen, as a condition precedent to the safe dispatching and proper inspection of trains?

Being somewhat familiar with its operations, I will select the Lake Shore and Michigan Southern Railway as a typical trunk line.

Of the entire engine service of this line, 25 per cent. is expended in the work of switching, and on the main line of 540 miles extending from Buffalo to Chicago, there is provided over 400 miles of

side tracks, for standing and switching cars and for passing trains.

The making up of trains and switching of cars requires much skill and experience, as well as systematic regulation. It is not infrequently the case that the blockade of a single yard delays and demoralizes the traffic of a thousand miles of railway.

The almost total suspension of business, resulting from switchmen's strikes, is a matter of newspaper record with which the public is more or less familiar, although none but those having experience can appreciate the intricacy and importance of this branch of the railway service. To surrender the control of switching yards to innumerable transportation companies and individuals, having trains to make up for the road, would be utterly impracticable.

As now conducted, cars are grouped in trains so as to minimize the amount of switching necessary. The railway company as now constituted takes the cars at hand, loads them and sends them on their journey to Chicago, they are reloaded there perhaps for Detroit, from there they go to Youngstown, etc. Imagine the labor and expense of collecting the particular cars owned by the dry-goods men, these cars being scattered in different yards along the line and being mixed with many others. After the first shipment of merchandise in their own cars, it would probably cost the dry-goods men of New York more to secure their return empty than the railway companies charge them for the full service of transportation, and unless they engage an army of men to follow the cars to their destination it is probable that many of them would never be returned. Even as it is, the car service of our railways is a most difficult one to manage, and the lines lose nearly all knowledge of their cars when once they leave the lines controlling them. They know that perhaps fifty cars are on some foreign line and they retain a similar number of cars belonging to other lines as a compensation for their loss. The different lines are supposed to return an accurate record of the movement of these, and pay mileage on the same, but the arrangement is anything but satisfactory, although probably the accounts for use of foreign cars by the different lines will aggregate over $100,000,000 annually. But manifestly the numerous companies and individuals engaged in transportation could not assume control of any cars other than their own unless they controlled the entire switching of the same. But to avoid monopoly either all or none must do the switching.

Then how could the dry-goods men of New York regulate the switching of their cars at the hundred different commercial centres to which they are consigned?

These illustrations might be multiplied, but those given suffice to show that the several States would be compelled to assume the regulation of this branch of the service. That the dry-goods men would have the right to rent or purchase their own equipment would be to little purpose, when an examination of the details of the business shows that the cost of transporting their merchandise would exceed by many times the rates now charged, which they call exorbitant.

It would evidently be necessary for the State to regulate the switching and handling of cars at station points and yards. Now as to warehouses, if the different individuals or companies moving cars were permitted to have their own store buildings, greatly extended yards and sidings would be necessary to accommodate them, requiring large and unnecessary extensions of terminals in our large cities, and this would still further complicate the problems which city governments and railway managers are endeavoring to solve.

It is then shown that to track repairs, engine, train and switching services, we would be compelled to add the station and warehouse laborers to the list of State employés, the only servants of the transportation company remaining being large numbers of freight and passenger solicitors, car and freight tracers and other supernumeraries the expense of which would be added to the present actual cost of transportation; thus, even though the States furnished as efficient service as the self-interest of existing railways now secure, the present cost of transportation would be considerably increased.

The tendency to combinations and the formation of pools and trusts is by no means confined to railway properties, and in the light of experience railway pools have actually proved less cohesive and effective than have the associations of various commercial and manufacturing enterprises. The right of eminent domain is not essential to the refiner of oil, yet the Standard Oil Company practically monopolizes that branch of business throughout the States. The same may be said of the sugar and similar combinations which legislation has thus far ineffectually aimed to check. Having regard for the many difficulties to be encountered by small companies and individuals engaged in transportation, we note all

the commercial conditions leading to a few vast car and equipment combinations, to monopolize the business much as the Western Union and Postal Telegraph companies now control their particular line of service. Thus the ownership of the railway beds by the State would most certainly result in conferring the power of monopoly now exercised by railway corporations upon the same individuals, who would reappear in the management of transportation and equipment companies. The local and territorial jealousies which under present conditions lead to rate wars and tend to obstruct the formation of binding associations and satisfactory pools would disappear, for the causes prompting those feelings would be removed, and the legal and commercial obstacles to the formation of car and equipment combines would be inconsequential in comparison with the complex interests which it is sought to harmonize by the organization of railway pools and kindred combinations.

To even approximate the present cost to the dry-goods men for the transportation of their merchandise, they would be required to perform the service of common carriers as a regular adjunct to their business, appointing agents in the towns to which they consign their goods in order to secure return loads for their cars, or else we would see box cars loaded with dry goods from New York to Chicago returning empty to be reloaded at the initial station, while at the same time similar cars laden with wheat would be unloaded in New York, returning empty to Chicago for another load. What is true of the dry-goods men as owner would be equally true of every small transportation company, so that all the conditions favoring the union and consolidation of equipment companies are to be found in the very nature and exigencies of the enterprise.

If, then, such combinations by the owners of cars and engines is so clearly foreshadowed, we must arrive at the conclusion that any attempt to secure the relief sought must include the State ownership of the cars and engines necessary to operate the railroads of which they assume the control.

The average rates charged the shippers of freight over the Lake Shore lines during the year 1890, was sixty-two and one-half cents per ton per hundred miles. It may be pertinent to here remark that, in the granger States where complaints against railroad extortion have been the most bitter, in wet seasons of the year it actually costs more to haul a ton of freight ten miles to market on the public highways than it costs the shipper for railway trans-

portation one thousand miles to the sea-board ; and yet it is urged that we turn the railways over to the same State authorities as now control the public highways, which betray such a lamentable record of incompetency or worse in the management of the public property with which they are intrusted.

The writer of the original article speaks of the Erie Canal keeping down the freight rates, whereas the fact is that in competition with the railroads the State of New York was compelled from time to time to reduce and finally relinquish the tolls, in order that the canal could in a measure compete for business as against the railroads. So in addition to the actual rates paid to the canal boatmen the people of the State are out the interest on the investment and the cost of operating and repairing.

It is shown that after taking possession of the railway tracks the States would be compelled to assume the entire business of transportation. Again referring to the Lake Shore road, we find the through line of this railway from Chicago extends 540 miles to Buffalo through six different States, as follows : Illinois 14 miles, Indiana 102 miles, Michigan 116 miles, Ohio 195 miles, Pennsylvania 44 miles, New York 69 miles. As at present operated it is cut up into divisions according to the natural conditions of grades, junction points and terminals but under State control these natural divisions would be extinguished and State lines substituted. The States could not engage in interstate commerce, hence they would be restricted to their own territorial limits and duplicate switching and standing yards would be required at the place of crossing each State line so as to properly transfer the business. Such a division of the traffic would introduce conditions even worse than those which existed prior to the consolidation of the several lines composing the Lake Shore Railway as now operated, it being a time when the rates of freight transportation were at least four times those which are charged to-day.

Surely this increased cost would not be tolerated, and the natural commercial division would survive, compelling the national government to take charge of the interstate commerce which the State at great expense had attempted to evade.

The federal control of the transportation business is admittedly unconstitutional and unwise ; therefore, may we not conclude that any initial step which inevitably involves that result must be foolish in itself and dangerous in its consequences ?

IS THE VALUE OF BOOK-KEEPING APPRECIATED ?

By F. W. Child, Member Institute of Accounts.

THE prevailing theories of "debit and credit," "assets and liabilities," and the like, seem so entirely foreign to the science of accounting that it is not surprising that the attempts of some who claim to be teachers and experts to harmonize these theories, have led many practical men to underrate the value of correct accounting as an element in contributing to the success of their enterprises, or in sounding the note of warning against disaster. Too many business men look upon their book-keeping department in the light of an expense from which they derive no sort of benefit, excepting as a guide for the collector and cashier as to how much they should obtain from their customers and pay to those from whom they purchase. In many instances this is due either to the fact that those whom they employ in this department are wholly incompetent to be anything more than copyists, and do not know how to properly arrange their accounts, or they are frequently restrained from so doing by the indisposition on the part of the employer of facing accurate information.

Every step in advance, whether in mechanics, medicine, art, or other branch of thought, and every achievement resulting therefrom, is but the sum total of all the thought and experience of those who have gone before. In recent years many societies have been organized in which every member contributes his mite to the store of knowledge, not only from his personal study of theories but also from his experience in their practical application. We have for instance in engineering, the Society of Mechanical, of Civil, of Mining, and of Electrical Engineers, and as many in other branches, where papers are read and discussed and new ideas are brought out and false ones exploded and discarded. So also we have in New York the "Institute of Accounts," embracing in its membership some of the most prominent accountants in this country, where accounting in its relation to all kinds of business and manufactures is discussed and analyzed with a view to more comprehensive methods and accurate conclusions, resulting in benefit to both the book-keeper and his employer ; and to this source I am

indebted for more practical knowledge on this subject than to any other.

To my mind there is but one kind of accounting and that is by double entry ; what is called "single entry book-keeping," containing a mass of data from which an accounting is attainable by the application of the principles of double entry.

The definition given by Charles E. Sprague, a fellow member, in a paper published in 1889, that "book-keeping is a history of values," his further statement that it is a "mathematical science," and his logical and consistent treatment of the subject from this standpoint seem to me to go to the root of the matter. "The mathematical side of this history," he continues, "consists in certain equations, in which addition and cancellation are the only operations employed." "Annals or chronicles merely relate facts which have occurred, but true history groups together facts of the same tendency in order to discover, if possible, the cause of happiness or misery, prosperity or ruin ; so, true book-keeping being a history, should group together similar values in their equations to discover the causes and effects of loss and gain.

"All operations in double entry book-keeping are transformations of the following equation : What I have + what I trust = What I owe + what I am worth, or symbolically written H. + T = O + X." "In the equations of accounts the answer sought, or unknown quantity, is 'What I am worth.' We will represent it by the letter X." A statement to the effect H + T = O + X is called in book-keeping a balance sheet or exhibit. It is made in various practical shapes to suit different cases. We will illustrate this with numerical examples. Suppose H = $10,000 ; T = $5000; O = $6000. Then, solving the equation by the rule of algebra, we find

$$X = \$10{,}000 + \$5000 - \$6000 = \$9000.$$

The practical way of writing the equation as a balance sheet would be :

H	$10,000	O	$6,000
T	5,000	X	9,000
	$15,000		$15,000

But space will not permit me to quote further from this most excellent paper. Enough has been given to show that accounting can be brought to a mathematical science, and be divested of all the meaningless terms and forms of speech which serve only to dis-

tract the mind from what is its true nature. I have listened to discussions of long duration, seriously entered into, on such questions as "Is capital an asset or a liability?" In the light of the foregoing there is no chance for such a question to arise.

There has been much said and written as to the value of commercial colleges as a means of preparation for practical office work. I do not presume to be qualified to discuss the methods of these institutions, and can only judge of them by those who have come to me seeking employment, and my acquaintance with some who teach. My general impression from these sources is that they teach a great deal that is useful, and much that is superfluous and confusing; that they pay too much attention to the keeping of a particular and prescribed set of books, and do not instill into their pupils the underlying principles applicable to all accounting; and this is doubtless due to the fact that, few who teach and write on this subject have been accountants, or if at all, not in positions where the business was sufficiently extensive to have themselves become practical; but the knowledge imparted as to the calculations incident to book-keeping and of the law applicable to certain transactions is valuable, and the practical application of them comes later, and on the principle that all knowledge is valuable, even to a book-keeper, they are undoubtedly doing a good work.

To the merchant who does only buying and selling, good accounting is an important element, and the lack of its appreciation has led many such an one into bankruptcy. By it they are able to note the effects of any change in their methods; if their worth at the end of any given period is less than they had reason to expect, they are able to trace the cause, and perhaps provide against it in the future; if they are dealing in different lines of goods they can determine which is the more desirable; if their expense account is unduly increased, the particular direction of the increase is clearly set forth; and much other useful information is obtainable which can be gained in no other way, and if gained in time may lead to success, where otherwise disaster would have followed. But when the element of manufacturing is added to that of buying and selling, the need for reliable figures becomes imperative. The subject of cost accounts is therefore one which should receive careful consideration, but in the space allotted here it can only be treated in a general way.

It is not to be expected that cost accounts will indicate how much can be obtained for goods manufactured; for this is deter-

mined by the state of the market, and price-lists must be constructed in conformity thereto, but they should show the lowest price at which they can be sold without suffering loss.

In order to accomplish this successfully it is certainly desirable, if not absolutely necessary, to treat the manufacturing branch of the establishment the same as if it were a separate establishment, charging all moneys which properly go into the manufacture to one account, and receiving back the goods from the factory at cost. Many manufacturers so confuse their books in the effort to keep but one set that they are practically worthless to indicate either the cost of their goods or the state of their business.

If the work is of such a nature that it can be done by "piece work," cost accounts, if properly kept, will give a basis for a scale of prices which is obtainable from no other source. The piece-work system has proved very advantageous to the many manufacturers, and with proper supervision and inspection the quality of work is maintained and the quantity or volume increased, thus insuring a greater output and consequently larger returns in any given period.

It cannot, of course, be claimed that the keeping of correct cost accounts makes a business successful or disastrous, any more than the keeping of correct accounts to indicate the worth of a business man will, of itself, enrich him. Success is dependent on the ability of the proprietor or of those whom he chooses to manage the different departments of his business, and good accounting is just as essential as good men in order to determine the most advantageous method of managing any particular kind of business. In these days of sharp competition, the manufacturer must depend mainly on his ability to cheapen the cost of his goods by improved methods of manufacture, and his accounts should indicate to him whether or not he is accomplishing his object by the methods adopted. It is impossible to give here, in detail, the best methods of keeping cost accounts, but generally they should not be so elaborate as to entail an expense on the manufacture out of proportion to the benefits derived, nor is this necessary, as they can be correctly and concisely kept under the supervision of an accountant familiar with this branch of work, but they should be so arranged that every dollar expended, whether in labor, material or expense, shall show in its proper proportion in each piece of work turned out, and so faithfully kept that there shall be no general account, such as stock, or repairs, which serves as a reservoir

for the reception of a host of charges not classified, and a menace to the correctness of the whole system. It should first be ascertained what per cent. the total of the expense account is of the total of the *labor* expended in the manufacture, and this per cent. so ascertained should be added to the *labor* on each piece of work turned out while the material charged to each piece should be calculated at cost price. Pardon me if I dwell on this a moment, as this is a point which is overlooked or disregarded by many in making up costs, and the results of their efforts are thereby distorted.

Raw material costs only its invoiced price until some labor has been expended on it. In the mine or forest it is worth nothing until the labor and expense of getting it to the manufacturer has been put upon it, and its value is increased to just this extent to the manufacturer, and when it reaches the consumer its value is represented by the amount of labor and expense due to the several transformations through which it has passed. (The profits in each case being here looked upon in the light of an expense in transmitting.)

The expense account in manufacturing books represents the value of labor and material which is necessary to the whole, and cannot be charged to any job in particular, such as that paid to watchmen, clerks, superintendent, etc., and for files, oil, coal and the like, and to distribute this alike on the labor and material in proportion to the total expense on a manufactured article, is not correct. We will say that the expense account is 10% of the total expense of the labor and material, charged directly to manufacturing account and 30% of the total expense for manufacturing *labor*, then, in an article where the material cost $17, and the labor $1, the cost would be $19.80 using the first percentage and $18.30 using the second. Whereas, if the material cost $17 and the labor $50, it would be only $73.70 by the first and $82 by the second method, so it would appear that using the lesser percentage on both material and labor makes the article on which the most labor has been expended and having the same amount of material cost less in proportion to this additional labor, whereas it certainly should cost more.

The efficiency of cost account is due in great measure to the excellence of the order system, the use of adequate means of recording and distributing the labor and material to the several accounts and, above all, to the employment of an accountant who

has had experience in this particular line of work and allowing him to supervise this department and holding him responsible for correct results.

This is a subject which is of interest to every business man, and I have attempted to give some answer to the question, which forms the heading of this article, and with the hope that it may lead some to a better understanding of the subject and a better appreciation of correct accounting.

ART AND UTILITY IN BUILDING.

By Barr Ferree,

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THE present is a time in which there is no definite relationship between architecture and engineering. In some grades of work the architectural element predominates over the engineering, in others the reverse is true. More unfortunate than this condition is the distrust that engineers and architects have of each other, some referring certain portions of a structure or a certain class of structures exclusively to the engineer, reserving other parts for the architect, and *vice versa*. The engineer is of course best familiar with his kind of work, and understands better what he has to do than the architect, who, in his turn, has equal familiarity with his special work. But the mutual relations of the two arts or sciences are not well understood, and the engineer and architect are constantly clashing with each other or erecting structures in which one or the other is ignored to the great disadvantage in the end. In other words, there is a tendency in modern building to give too great prominence to engineering or construction on one hand, or to architecture or æsthetics on the other.

A glance at some of the previous periods of architectural activity will show the usage in former times, and how successful the union or disassociation of engineering and architecture was. And such a study cannot but be helpful in determining the relations of these arts at the present day. The history of civilized man is progressive and the past is not always a safe criterion by which to judge of the present. But however advanced man may become, he cannot afford to neglect the lessons and experiences of previous times. It is the accumulation of these experiences which makes his life at any one time further advanced than at another. The most ordinary prudence would therefore suggest a study of past methods in building, even if the volume of previous architecture was not superior in architectural results to the modern. Early practices cannot fail to contain valuable suggestions, and early methods will often prove fruitful of ideas that will be beneficial to the modern inventor and designer.

The Romans were the first great engineers, and in their own

particular manner have never been excelled. Their genius was more of an engineering quality than architectural, and it is in this department they erected their most successful structures. Architecturally, though of wonderful variety and imposing magnitude, Roman art was too rich, too great a combination of diverse elements to be thoroughly artistic and in keeping with refined taste. The barbaric Etruscan element in the Roman character which found visible expression in their gladiatorial and bloody shows, was too strongly rooted to be eradicated even in the centuries of independent Roman existence. The many lands which Roman conquerors placed under their city's sway made them familiar with a great variety of architectural forms they did not hesitate to avail themselves of, and the result was a combination, wonderfully rich and impressive, but often violating the canons of architectural art. Measured by the faultless standard of the Greek, its immediate predecessor and the model it most closely followed, Roman art leaves much to be desired from the æsthetic standpoint. But however unsatisfactory the Romans were in architectural design, and it must not be forgotten that after all it is the purist who chiefly finds fault with them, they more than made up as constructive builders. Construction was the Romans' chief point of excellence, and they brought to this work a native genius and an insight into engineering requirements of a very high order.

The arch was the basis of Roman engineering, the vault the foundation of Roman architecture, though the arch was of course its natural accompaniment. The great hall of a Roman palace was a piece of skillful engineering in which the arches and vaults were adjusted to perfectly answer the structural requirements of the edifice, and were combined in a manner which gave the greatest floor space to the least amount of supports so far as the Romans understood regulating these two important elements of building. Built in what is popularly known as rubble work, though a recent writer has maintained that this is not the correct term to apply to the body of Roman walls, which derived its chief strength from the powerful mortar employed with it, Roman construction contained nothing but what was absolutely essential to the stability of the structure. This state of affairs did not please the luxurious Roman, and he ornamented his building within and without with columns, entablatures, panels of costly marble, and other rare decorations which had an architectural form and which were apparently performing an architectural duty, but which, in reality, were nothing but orna-

ments and had no structural capacity. And this, notwithstanding its very splendid results, notwithstanding its superb monumental character, its lavish gorgeousness, its almost unrivalled magnificence is the chief fault of Roman architecture. It was superb engineering, but not good architecture if by architecture we are to understand—and there can be no question of the correctness of the definition—the proper application of artistic ideas and elements to constructive necessities. The columns and entablatures of the Roman edifices were often very beautiful and worked with great skill and care, but structurally they were quite unnecessary: the building stood unharmed by their fall, unstrengthened by their presence.

But however unsatisfactorily the Romans mingled engineering with architecture in their ornamental and monumental edifices, they pursued quite a different course in structures which were distinctly engineering in character. In their bridges and viaducts, which are among the most important works of any kind they undertook, they confined themselves to the structural requirements of the task at hand. Their arches and piers were useful, not ornamental, and there was none of the overloading and application of ornament which was so marked in architectural erections. Yet it cannot be supposed the Romans were indifferent to the æsthetic appearance of their viaducts nor that their bridges were designed without reference to their effect upon the mind of the spectator. Their arch is a more artistic member than it is at the hands of modern engineers, who rely chiefly upon the beam and truss for their work, and a succession of bold arches stretching across a piece of country as far as the eye can see has an æsthetic value and character of a very well-marked order. It would have been difficult with their materials for the Romans to have produced an unartistic work of engineering. That they did not try to approach the model of their architectural work is due not only to this artistic value of the arch but to their sense of the unfitness of spending large sums of money in unnecessary ornaments. In some respects their buildings are greater triumphs of engineering than their viaducts. More complicated problems are concerned in the arrangement of vaults and arches than in building an indefinite stretch of arches alone. Yet in their architecture the Romans did not make a wise or reasonable combination of engineering and architecture. Both elements were employed together, but not jointly. One did not help the other: each stood alone on its own merits. Their engineering was more satisfactory artistically because it was composed of a good archi-

tectural member, that in the simple manner in which it was used could not be deficient in artistic merit.

The structure of a Roman edifice contained no artistic elements. The ruins of the baths of Caracalla at Rome, one of the most stupenduous and elaborate of Roman edifices are imposing it is true, but not artistically interesting. They have mass, but no other quality to recommend them. And this brings us at once to the chief lesson Roman architecture can teach us at present, namely, that an engineering work may be artistically beautiful if treated intelligently and properly, as in Roman viaducts, and that an unorganic union of engineering and art as seen in the Roman palace or bath is unsuccessful as a whole and false to the individual merits of the two elements that are brought into connection. The result is neither good engineering nor good architecture. Each suffers from the juxtaposition of the other. There must be an intelligent combination or none at all, an intimate relationship or a complete severance of connection. Roman architecture teaches us further that engineering structures in which architectural possibilities are thoroughly ignored can have no artistic merit, and the example of the viaducts might further show us that it is wise to give an engineering structure an artistic form. The Roman engineer was fortunate in having at his command no unartistic material, but his work shows us most unmistakably that an artistic quality is quite as desirable in engineering as in architecture.

Postponing for the present a further consideration of this fact, it may be of interest to glance briefly at the architecture of the middle ages. The Gothic period was much more artistic than the Roman, and in some respects, in the multiplicity of monuments and the perfection with which they have come down to our day, it stands quite alone. Here in a much more developed state is found the application of artistic ideas in engineering structures than in any building epoch. The great castles, donjons and keeps of the early mediæval and Gothic period, the bridges and military erections of the time all have artistic merits which do not in the least detract from their engineering qualities, but, if possible, render them more attractive and useful. In architecture proper there is a much closer union of architecture and engineering than is to be noted in the Roman period. Gothic architecture in its most developed state is a scientific application of art forms to structural requirements. It may seem unusual to speak of a Gothic cathedral as a piece of engineering, but few structures which claim to be careful works of

engineering are so delicately adjusted or so wonderfully fitted to the scientific work they have to do as a Gothic cathedral. All the component parts of Gothic architecture, the development of the arch, column and vault, the buttress and flying buttress, the pinnacle and even the tracery of the windows and ornamental features like the gargoyle originated through structural necessities, and those buildings in which they most accurately meet the structural requirements and are applied with the most scientific precision are the most successful and most beautiful examples of Gothic art.

Like the Roman the Gothic engineer had the singular good fortune of knowing only materials that had artistic form and were capable of artistic combination. He was much more happy in having elements that were capable of more artistic combinations and produced vastly more artistic results than his predecessor, and possessed also a keener, more delicate and refined artistic temperament; which caused him to give an artistic form to almost every sort of work he undertook. His castles and military works were not over-ornamented structures, but scientific constructions which, while ornament entered into them to the slightest extent only, had a decided artistic charm. Often the solitary decoration of the mediæval castles was a piece of sculpture over the doorway which filled a necessary object in giving this important feature a monumental character, but the design of the towers, the arrangement of the roofs and battlements were treated in so artistic a manner as to make the entire structure both beautiful and useful. It is rare that anything but what is absolutely necessary and useful was employed in these buildings ; it was equally extraordinary if they were devoid of artistic character.

It is unnecessary to prolong this discussion by an examination of Gothic construction ; it is sufficient to remark that an analysis of a Gothic edifice shows it to have been built on a most scientific basis. In one respect Gothic construction widely differed from Roman. Roman construction was unartistic ; in the Gothic style the ornamental parts were so largely constructive that the building would fall on their removal. This is the principle on which Gothic art rests, and no part of it is more remarkable than the manner in which elements that were originally purely constructive and without artistic or ornamental value become in process of time an important part of the decoration. Yet even in these instances they do not lose their constructive value, nor is their place in the construction taken by new members. They still do their old work, but in a

more artistic and ornamental manner. A single example, the evolution of the vault, will serve to make this clear. Primarily the vault is construction pure and simple. Its inner surface gives, it is true, an ornamental finish to the room it covers, but in its origin it was a scientific solution of the problem of covering a given area without intermediate supports. The invention of ribs speedily permitted the mediæval builders to modify the simple groined vault and by introducing new members and surfaces not only to vary the form of the vault but to render it more applicable to the space it had to cover. The later developments of English vaulting show a great multiplication of the ribs with an increased artistic and ornamental effect. In the very latest form of Gothic art the tendency to give the construction members an artistic form was much overdone, but this should not blind us to the value of the correct application of the principle.

Roman and mediæval art furnish excellent illustrations of the application of art to engineering. In many respects the methods of the builders of these periods are quite different from those practiced by the engineer of our time. It would be a great injustice to say that the average engineer does not care for the art side of the building if it is structurally correct and answers the requirements for which it was erected. It would be equally unfair to maintain that the architect on his hand looks more to the art of his building than to its engineering. There is, however, a very decided tendency in both these directions, and in no instance is it more to be regretted than in the case of the engineer. A large part of the building of the country is passing into the hands of engineers. The bridges, viaducts, railway stations, warehouses, factories, mills, and similar edifices if not actually in the majority of cases, designed by engineers, are built as pure pieces of construction without regard to their artistic possibilities. The engineers are perhaps more to blame in ignoring the art aspect of their erections than the architects in neglecting the engineering side and treating their special work as that of ornamentalists only. The most advanced ideas and methods in construction are not always requisite to the stability of a building, but an unartistic piece of engineering obtrudes itself into the landscape in the most preposterous manner possible and defies being overlooked. Forthwith is raised a mighty outcry and there is a loud demand for the suppression of the engineer.

And there is reason in the protest. The work of an architect

is not always necessarily good and he is frequently erecting the most frightful edifices, but these have the good fortune to be generally located on a street and can be avoided by going down another. The work of the engineer, however, is too frequently one that concerns the necessities of the public, and is where it cannot be overlooked. In these circumstances any great disregard of architectural possibilities is a public calamity. The root of the trouble lies in the antagonism between two elements, engineering or construction, and architecture or decoration. Architecture is not decoration or architectural construction, but there is a popular delusion that the two terms are synonymous and for the present purpose the matter can be passed over as this without further comment. If engineers were to give greater attention to the art possibilities of every structure the result would be not only an improvement in architecture generally but in the appearance of our engineering structures. Engineers have a great disadvantage in working with the beam and truss, two elements which have not yet been given satisfactory artistic form. The beam itself is not incapable of artistic treatment as the architecture of ancient Egypt and Greece most manifestly shows. Modern builders, however, have not yet mastered its artistic qualities, if they have even begun to understand its full structural value. This condition of things can only be changed by giving greater attention to the art possibility of structures. The remains of the Roman and Gothic periods show very conclusively that buildings may have a high degree of artistic finish and still possess the best of engineering qualities, and the builders of to-day should be able to accomplish what men 1000 and 500 years ago were able to do.

It sometimes happens that an engineering structure will have artistic qualities of its own without any special attention having been given to them in the process of construction. The New York and Brooklyn Bridge is a noticeable illustration of this fact, the fine curve of the roadway being of extreme lightness and beauty. The unconscious artistic result, if such it may be called, is too rare to be relied on to any extent, and it is necessary for the engineers to give the question serious study before any improvement in modern methods can be anticipated. There has been within the last few years more attention paid to construction than to any part of architecture. Builders have supposed that in employing the most advanced methods of construction, in reducing expenses and using only such forms and parts of build-

ings as are absolutely necessary they are not only conferring a favor upon their patrons but making actual progress in art at the same time. Economy in architecture, as in all other things, is eminently desirable, but there is no reason why an economically constructed edifice should be ugly nor why an artistic structure should be necessarily expensive. Beautiful things of course cost money, but mere expense does not make art good nor are the most costly structures the most satisfactory from an architectural standpoint. Engineers, however, have become impressed with the idea that economy in all things is the first consideration, and that every piece of ornament is a useless appendage. It is an easy step from this to suppose that ornament or an ornamental appearance is quite unnecessary in an engineering structure, and then comes the total disregard of art that is so frequently marked in engineering enterprises.

The solution of the difficulty lies in union, in accepting the artistic element, as well as the purely constructive. When this has become thoroughly understood and generally accepted as a fundamental maxim, then will engineering take to herself those artistic qualities without which she is but an undeveloped art. The history of previous art shows what success such treatment met with; the history of modern art shows how unsatisfactory is the opposite method. An unprejudiced comparison of the methods of the two epochs will show which is the truer art, which the better construction, which the better model to follow.

THE COMMON ROADS OF EUROPE AND AMERICA.

By Isaac B. Potter, C. E.

OF all things in the domain of common property the public road is the most used and the most conspicuous. Nor is there a more certain index of civilization,—of national character; for, leaving aside those isolated cases of sectional prosperity due to the discovery of undeveloped natural wealth, it may be said that the condition of the common roads in any established state is no mean exponent of the progressive character of the people. "The road," says Bushnell, "is that physical sign or symbol by which you will understand any age or people. If they have no roads they are savages; for the road is the creation of man and a type of civilized society. If you wish to know whether society is stagnant, learning scholastic, religion a dead formality, you may learn something by going into universities and libraries; something also by the work that is doing on cathedrals and churches, or in them; but quite as much by looking at the roads, for if there is any motion in society, the road, which is the symbol of motion, will indicate the fact." To the man who reads to consider and who travels to observe, these facts will become doubly impressive.

ITHACA, N. Y. SCENE IN CITY LIMITS NEAR STEAMBOAT LANDING, APRIL, 1891.

The ancient Romans were great, not alone by reason of their conquests in battle; for behind the power which inspired the valor and directed the success of the legions, a great social and political intelligence kept pace with the problems which the spread of the empire brought forth. Taking heed of the splendid example set by those industrious road-builders the Carthaginians, Rome laid a network of roads throughout her territory, so splendid and so permanent that not a few of them are in use till this day. All highways led to the imperial forum, and these highways were extended from time to time into new provinces as conquests went on;—always splendidly made and well kept, and forever standing as mute witnesses of Roman intelligence. The influence of that work is imperishable. No lesson is so powerful to mankind as an object lesson. The masses are always copying, forever imitating; the few only advancing. The roads of the empire outlived the empire itself. Through all the sad years when learning ceased, when art and science were dormant and commerce dead, the roads of the Romans were neglected. Many were destroyed, but some remained, and in the revival of learning these roads have, during the last two centuries, supplied a potent and civilizing influence throughout all Europe.

About thirty years after the discovery of America, the British Parliament attempted some feeble legislation for the improvement of the English roads; but there were more politicians than statesmen in that day, and a general apathy prevailed in most matters which promised industrial benefits. A great historian,* writing of the condition of the common roads of the kingdom a hundred and sixty years later (1685), shows that no substantial improvement has been made in all that interval. His description of the British roads of 1685 would be most interesting to any reader who may be familiar with the condition of the country roads of the United States to-day and to one who will trace the lines of English history from that day to this, it will appear that the several steps of improvement which have led to the final attainment of England's superior roads, have been taken hand in hand with the development of the social and industrial energies of her people. Before railroads came into use in the United Kingdom, the only public conveyance used for inland travel was the coach; yet even in the busiest days of coaching, travel by the common roads was difficult. In rainy weather the route for miles was often through one contin-

*Macaulay.

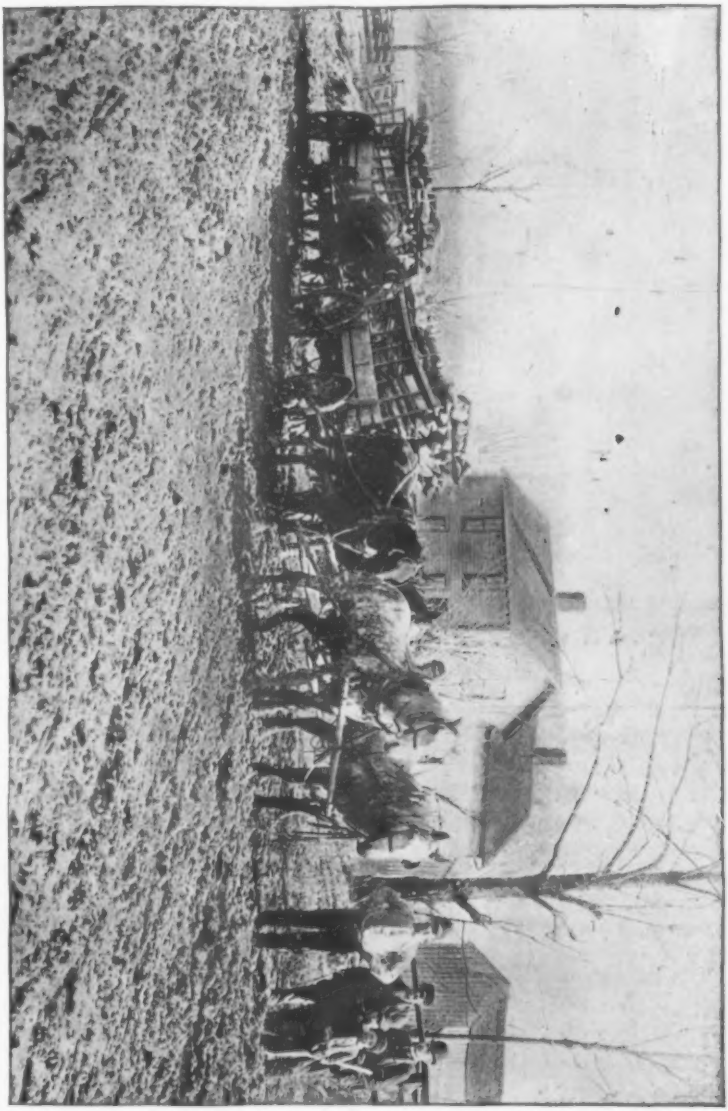
COUNTRY ROAD BETWEEN OXFORD AND READING, ENGLAND.

uous quagmire, and it is said to have been a matter of almost daily occurrence for the public coach to become hopelessly stuck in the public slough where it remained until lifted out by the aid of a yoke of cattle from some neighboring farm. At that time the laws of England imposed a method of "working out" the highway tax strikingly similar to that in use in most parts of our country to day. For many years improvement of the common roads in England was hindered by this system of statute duty. The roads of the kingdom were maintained by a system of "parish management," and persons were chosen each year to serve in the various parishes as surveyors of highways. They were much the same as our highway commissioners and other highway officers employed in the various counties of the United States. They had no special knowledge nor aptitude for the work placed in their charge, and the result was that the English dirt roads of sixty years ago were kept in the same miserable condition in which we find our own highways to-day. In those times every Englishman who kept a team of horses was liable to be assessed to do six days team work, while those few farmers who kept no horses paid money instead. Plenty of work was done, but the art of road-making was not un-

derstood, and so the labor went to waste and resulted in no permanent improvement. In the repairing of the common roads at that time it was said by Macadam that there seemed to be "no other idea of mending the road than bringing a great quantity of material and shooting it on the ground."

In 1819, while the question of improved roads was occupying the attention of Parliament about in the same manner that it attracts the attention of the legislative bodies of the United States to-day, Telford appeared before the parliamentary committee on roads and highways and gave graphic testimony of the condition of the British roads of that period. The interest then awakened grew from year to year till 1835, when Parliament passed the general highway act, and from that date began the systematic and intelligent management to which the superior quality of the English roads is now principally due.

But England is by no means alone in her possession of good roads. The Roman legacy has in late years multiplied its value, and in nearly all the countries of Europe systems of high class roads are maintained. In Ireland they add not a little to the delights of the picturesque Killarney district, and are everywhere found by the tourist and traveller who visit that beautiful country. In France you may drive from Paris to Orleans, to Bourges, to Nevers, and across the Jura Mountains into Switzerland. You may journey through Switzerland, beholding all her marvels of scenery, and you may continue on into Germany and follow the Rhine and its valley of legends, till you reach the shoals of the North Sea. You may vary this journey in whatever way your inclination may urge; you may travel the roads of Scotland, Italy, Austria, Belgium, Baden, Spain or Scandinavia, and you will everywhere find that the public hand has been industriously directed to the care and keeping of the common roads. Each of these countries has established, within its civil government, a department having exclusive control of the more important highways, and in most cases also a supervisory management of the parish and branch roads which connect the smaller towns and serve as feeders to the main lines. Varying, of course, in some degree as to details of management, there is still a practical unanimity among the great nations of Europe in this policy of governmental control. It began with the popular recognition of two facts: (1) that the public road, like the public post-office and the court-house, is public property, established by law for the use of all people; and (2) that the



MAIN ROAD BETWEEN CLEVELAND, WARRENSVILLE AND CHAGRIN FALLS, OHIO. SCENE 1 3-4 MILES FROM CLEVELAND, MARCH 28, 1891. TEAMS STUCK IN THE MUD WHILE EN ROUTE TO THE CITY. THIS IS A MOST IMPORTANT ROAD, USED LARGELY BY FARMERS LIVING SOUTHEASTERLY FROM CLEVELAND.

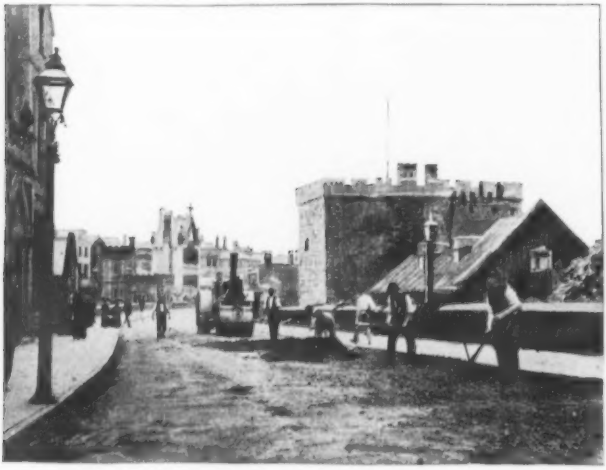
extravagant waste of time, labor and property which had been for centuries imposed by the use of mud roads could only be checked, and the true resources of the country brought out, by the construction and maintenance of good roads under an intelligent head. This was the doctrine of Trésagnet and of his English disciples, Telford and Macadam, and events have verified it. An exhaustive examination by the writer of reports and statistics collected in twenty-three separate European states, shows that in each case the quality and condition of the public roads are raised or lowered in about the same measure that the general government bestows or withholds its official direction. Witness the splendid results in France. From the work of the Romans, Trésagnet learned that the road was a structure; that it should have a foundation; and, adding to that the light of later knowledge, he built hundreds of miles of better roads than the Romans ever knew. The spirit of this reform took hold upon the government, and to-day France has about 130,000 miles of "macadamized" roads. Thousands of skilled men are everywhere employed, each on his separate section of the road, and all are under the constant surveillance of the official inspectors, by whom they are held to strictest account for the work in their charge. No department of government could be better equipped, and no government could be more closely in touch with the details of public work than is the Republic of France with the care of her common roads. System prevails everywhere. The result is that the roads of France are probably the most perfect in the world.

What is the commercial value of these high-class roads? It is difficult to estimate it; and were we told we could scarcely believe. The nimble-witted Frenchman spends eighteen millions of dollars per year to keep his roads in good repair. He will tell you the reason for this in two words. "It pays." He knows that a horse can draw twice as much load on the surface of a macadamized road as upon a dirt road in its best condition; four times as much when the dirt road is in its average state, and ten times as much as when the dirt road is turned to mud by the rains of fall and spring. He will tell you that good roads will increase the value of your farm; shorten the distance to market; save time, wagons, harnesses, horses; enlarge the territory which contributes to the home market; quicken social communication, and add to the wealth of the individual and the state. The American farmer will doubt, but the Frenchman knows; he has tried both ways. The writer has before

BERKLEY STREET, WAYNE JUNCTION, PHILADELPHIA, 1891. ROADWAY IMPASSABLE FOR HEAVY LOADS.

him a letter received from a friend in Paris some weeks ago in which extended reference is made to the roads of the republic. A few brief quotations would be here appropriate: "Carriers' wagons still make weekly and semi-weekly trips to the cities from towns thirty and even sixty miles distant. * * * The tires of these vehicles are usually wider than at home. Three or four inches is the average width, and there is a law forbidding tires to be too narrow. * * * One horse generally pulls what would be considered a good load for two in America, and the only limit to the load is reached when there is no space or corner left to stow any more burden. Not only do they load down the roofs of their wagons, but also hang huge bundles upon the sides; and beneath the cart, between the wheels, swing as many big baskets and boxes as they can stow in. The cart being loaded, the good man and his wife and one or two others climb in; then crack! crack! goes the everlasting whip in a succession of rifle-like reports, and 'Cocotte' trots away with her gigantic load as merrily as you please."

It is impossible to read the history of reform in European highway management, and of the heroic work of the men to whom the credit of that reform is due, without noting the fact that the



REPAIRING MACADAM ROAD IN YORK, ENGLAND.

friends of good roads who fought their battles for better laws in the British Parliament were only pioneers in the same work in which many intelligent Americans are engaged in to-day. Theirs was a task which it took years to accomplish. They were met by the same arguments which impede the movement in this country sixty years later; their motives were doubted, their methods criticised, and their final success was attained only by the most persevering steps. If our common boast that we are a progressive, wide-awake and ingenious nation is well founded, what can be urged to excuse us for adhering to the antiquated and inefficient methods of making and keeping our common roads when we have before us the great economy and splendid results produced by the adoption of more intelligent methods in other countries? In many respects we have greater need of hard-surfaced roads than has either France or England. Our rainfall is considerably heavier than theirs, and our dirt roads for weeks at a time are half as deep as they are wide. Farm traffic is suspended, and horses are kept in idleness. Official statistics show that there are something over 16,000,000 horses and mules on the farms of the United States, and at a moderate estimate of twenty-five cents per day as the cost of feed for each animal, we see that it costs the farmers of this country about $4,000,000 per day for this item alone. Less than fifty

per cent. of these animals would be sufficient to do all the hauling of farm produce carried on in this country if even the main roads were put in first-class condition; but, not to hope too strongly for the attainment of distant things, let us suppose that such an improvement be projected as would render unnecessary only one-eighth of the total number of the draught animals now employed. This would reduce the entire number by a little over 2,000,000 and would effect a saving each day of about 14,000 tons of hay, and 750,000 bushels of oats, which, reduced to a money value, equals $300,000 per day or about $114,000,000 per year. Add to this the value of the animals, $140,000,000, and we have a total $254,000,000 saved for the first year. Of course these figures do not represent the real loss entailed to our farmers by the use of dirt roads. That loss is beyond computation; but in whatever way the computation is directed, and wherever the loss is susceptible of calculation, the same startling exhibit is bound to appear. A recent careful count shows over three hundred abandoned farms in the fertile and populous State of New Jersey. These farms in

MACADAM ROAD FROM GLENARIFFE TO KILLARNEY LAKES, IRELAND.

France, Italy or England, located the same distance from market, and with no added advantages save those offered by the better highways of Europe, would present a spectacle of thrift and bounty such as their discouraged owners never dreamed of. And even in New Jersey the quickening influence of high-class roads has begun to assert itself among the more intelligent classes. In Union County the recently completed macadam roads have so raised the values of all adjacent property that a recent official estimate places the average value of Union County farms at $206 per acre as against an average value of $65, for the entire State. It is needless to say there are no abandoned farms in Union County.

But the question is frequently asked: "Can the people of this country afford to build and maintain high-class roads? Is not ours a new country and can we expect to rival the countries of Europe in the construction of costly internal improvements?" The answer to these questions is forever ready. Ours is not a new country. We are rich and populous;—we claim to be intelligent and enterprising. We have cleared up our forests and exterminated the last wild beast from most of our States years ago, while the French government is still paying a yearly bounty for the pelts of slaughtered wolves. A glance at the statistical returns of New York, Pennsylvania, Massachusetts, New Jersey and Connecticut will show that the population per square mile of these States is more than fifty per cent. greater than that of Europe, while a dozen other States might be added to the list without materially changing the ratio. We are scarcely aware of our own prosperity. From statistics lately compiled by one of the great commercial journals of the country, it appears that the total wealth of the United States is now more than seventy-one thousand millions of dollars, or about one thousand dollars for each man, woman and child in the entire country. This is an increase of eighteen thousand millions of dollars or about forty two per cent. within the last ten years. According to the last accredited statement this gross amount exceeds England's wealth by about twenty-one thousand millions of dollars and amounts to about twice the total wealth of the Republic of France. In the matter of taxes, England exacts an average of twenty dollars per head from each of her entire population, while the average tax per individual paid in the United States (where the farmer and mechanic are better paid, better clothed and better fed than their European neighbors) is but twelve dollars and fifty cents. By way of emphasis, and to indulge these statistics a little

MACADAM ROADS IN "PRINCE OF WALES ROUTE" BETWEEN BANTRY BAY AND KILLARNEY LAKES, IRELAND.

further, it is shown by the official reports published by the general government at Washington, that in the year 1889 the thrifty American had deposited in the various savings banks of the country, nearly fourteen hundred millions of dollars, being an increase, within the last six years, of nearly three hundred millions of dollars in money and an increase of about eight hundred thousand individual depositors. In gold, silver and metallic products we are producing about three hundred and fifty millions of dollars per year, and in mineral products (other than metals) nearly an equal amount. The value of gold, silver and domestic merchandise exported from the United States in the year 1889 is more than eight hundred and ten millions of dollars; the product of pig-iron and steel railroad bars in 1888 was more than one million four hundred thousand dollars, being an increase of about two hundred per cent. since the year 1870. Of sugar, Louisiana alone, in 1889, raised about one hundred and seventy thousand tons, while the raw cotton production of the South, during the same year, amounted to about seven millions of bales, weighing about

one million seven hundred thousand tons and having a farm value of about three hundred millions of dollars. Under any conditions, and most of all under these conditions, a dirt road is a costly investment. The actual cost of repair of the common country road under our "working-out" system is immensely greater than the cost of keeping a similar length of macadam road under a systematic plan; and worst of all, through our want of knowledge, both work and materials are wretchedly misapplied and, in most cases, practically thrown away.

It is, however, a happy circumstance to note that the matchless importance of this question has begun to be recognized in the councils of our Government and of many of the separate States. In a recent annual report of the Commissioner of Agriculture, reference is made to the condition and needs of American roads in language so timely and so forcible that it might be well quoted to serve as the closing paragraphs of this paper. The Commissioner says:

"The common roads of the country are the veins and arteries through which flow the agricultural productions and the agricultural supplies, which are the life blood of the nation, to these great ducts of travel and transportation—the railroads of the country.

"While our railway system has become the most perfect in the world, the common roads of the United States have been neglected and are inferior to those of any other civilized country in the world. They are deficient in every necessary qualification that is an attribute to a good road; in direction, in slope, in shape and service, and most of all, in want of repair. These deficiencies have resulted not only from an ignorance of the true principles of road making, but also from the varied systems of road building in force in the several States in the Union, due to defective legislation. The principle upon which the several States have based much of their road legislation is known as the "road tax" system of personal service and commutation, which is unsound as a principle, unjust in its operations, wasteful in its practice, and unsatisfactory in its results. It is a relic of feudalism borrowed from the "statute labor" of England, and its evil results are to-day apparent in the neglected and ill-conditioned common roads of the country.

"It is a question of vast importance to the welfare of this nation that these arteries of agricultural and commercial life should receive the attention that their importance deserves, and that an effort should be made to remedy the defects now existing and es-

tablish a system that could be made uniform and efficient in all the States of the Union.

"By the improvement of these common roads every branch of our agricultural, commercial, and manufacturing industries would be materially benefitted. Every article brought to market would be diminished in price; the number of horses necessary as a motive power would be reduced, and by these and other retrenchments millions of dollars would be annually saved to the public. The expense of repairing roads and the wear and tear of vehicles and horses would be essentially diminished, and the thousands of acres of land, the products of which are now wasted in feeding unnecessary animals in order to carry on this character of transportation, would be devoted to the production of food for the inhabitants of the country. In fact the public and private advantages which would result from effecting this great object in the improvement of our highways are incalculable, not only to the agricultural community as a class but to the whole population as a nation."

Let us hope for the development of that rare and splendid type

GRANITE AVENUE, DORCHESTER, SUFFOLK CO., MASS., SIX MILES FROM BOSTON CENTRE. MOST OF THE GRANITE FROM QUINCY AND EAST MELTON QUARRIES IS HAULED OVER THIS ROAD. ALSO MUCH USED FOR GENERAL TRAFFIC.

of statesmanship in our own country which looks to the good of the State, discerns its material needs, and asserts a leadership in those avenues of national advancement which tend to the social and material enrichment of the Republic.

THE CELEBRATED NATURAL LIMESTONE ROAD BETWEEN HAMILTON AND ST. GEORGES, BERMUDA.

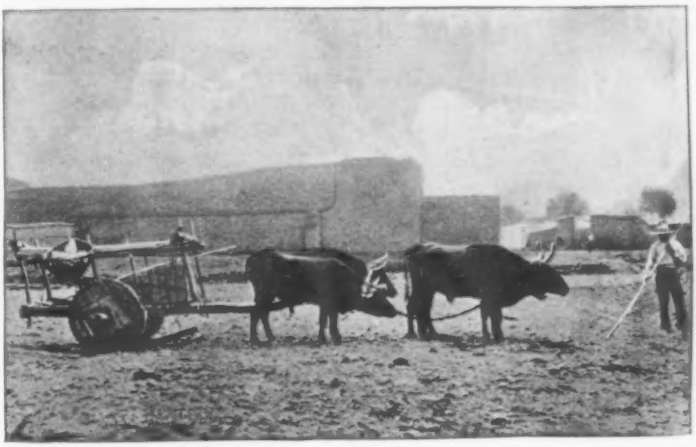
THE PAN-AMERICAN RAILROAD.

By F. W. Conn, C. E.

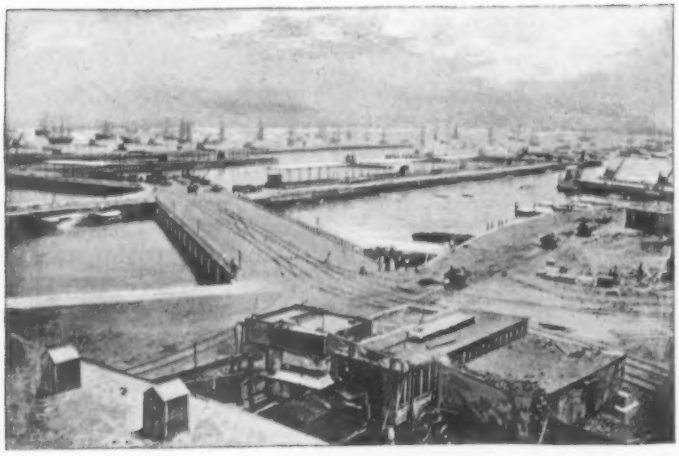
THIS project to unite North and South America in more senses than one, by means of the Pan-American Railroad, seems to give the pessimists considerable unnecessary trouble. However free individual opinion may be, it is no part of public spirit to condemn an enterprise without a full knowledge of all its possibilities. In the present instance adverse comment has been made, not infrequently, in entire ignorance of the facts.

Indeed, there are not great numbers of people in this enlightened country of ours who can give the boundaries of any one of the Central American Republics. Is it not a fact that a majority of the people in the United States know less about our southern neighbors than they do of the vague territorial limits and bounds in Central Africa?

The feasibility and practicability of this road is apparent to every one who has any knowledge of Spanish America. While we are thinking about it, the scheme is slowly but surely developing in



MEXICAN OX CART.



HARBOR AND DOCKS, CALLAO.

the natural course of events. The Mexican Central annihilated 1224 miles. The Mexican Southern will, in a few days, make the distance 450 miles shorter. One can enter a Pullman at Buenos Ayres and ride 1000 miles towards New York. While the obstructionists are shaking their heads, the 17,000 miles of railroad in Central and South America are handling European merchandise, and pouring the products of the country into the holds of the subsidized steamships of England, France and Germany.

Of the total imports of Central and South America the "First and Foremost Nation on Earth" contributes seven per cent. Of the exports we get about twenty per cent. These comparatively undeveloped countries, with an area two and one-half times that of the United States and Alaska, have a commerce at the present time amounting to $869,482,998. Is it not worth while to assist in the construction of 3000 miles of railroad to obtain this trade? The action of the Pan-American Conference has made the construction of this road an international affair and has put the project on a better basis than if it were to be attempted by independent parties.

There are no serious engineering difficulties to be overcome. There is no need for the line to get tangled up in the Sierra Madres or the Cordilleras. Taking Oaxaca as the southern end of the rail, the most difficult work of the whole line would be getting

GULF OF MEXICO
MEXICO
CARIBBEAN SEA
ATLANTIC OCEAN
COLOMBIA
VENEZUELA
BRITISH
DUTCH
FRENCH
GUIANA
ECUADOR
BRAZIL
PERU
BOLIVIA
PARAGUAY
URUGUAY
CHILE
PACIFIC OCEAN
RIO JANEIRO
RIO DE LA PLATA
RAILROAD MAP
CENTRAL AND SOUTH AMERICA
showing route of
INTERCONTINENTAL R. R.

out of the mountains south of this city. The Mexican Southern has made a survey through the range coming out on the coast plain near Puerto Angel and continuing down the coast to Tehuantepec. In my opinion the best route for the proposed road is down the Pacific side hugging the foot-hills.

Speaking as I do with profound interest and conviction on this subject, I should like to say that I gained what little information I possess in regard to Spanish America while "rawhiding" up and down the country for ten years, and not by dodging in and out of the principal cities like a personally conducted globe-trotter.

The country between Oaxaca and Tehuantepec is decidedly rugged and there will be considerable rock work. The mountains are covered with magnificent pine timber and are rich in minerals. Barley and corn are the principal crops, but hardly enough is grown for home consumption. The natives of this section of country are strong and hardy and will make good laborers. The question of labor for the construction of the Pan-American railroad is one that will require careful study. Labor is scarce and not particularly good in Central America. The same is true of some parts of South America. Many of these republics object to imported labor and I have known contracts to be signed containing a clause forbidding the use of "African or Asiatic labor." A contractor accustomed to ten hours a day and no smoking, will have to learn the business over again. Labor in Central America is apparently cheap at from 25 to 50 cents per day but it is not worth more. Everything is done by task-work and it is difficult to make an Indian understand any other way. The best way on railroad work is to give each small gang a certain number of stations, with the distinct understanding that they are to receive no pay until the work is completed. They will not earn their salt working by the day.

The country between the Isthmus of Tehuantepec and the Isthmus of Panama, on the Pacific side of the Sierra Madres, is nearly level, wonderfully fertile, and is the natural location for the Inter-Continental railroad, as being the shortest route and cheapest of construction. Between Tehuantepec and the boundary of Guatemala, across the State of Chiapas, the country is thinly peopled and entirely undeveloped. The vegetation is most luxurious and one can ride day after day through the forest wholly shaded from the sun. The jungle is so thick that it is impossible to leave the trail without cutting your way with a *machete*. Mahogany,

PLOUGHING WITH MULES, MEXICO.

(several varieties) logwood, rosewood, cedar, and the rubber tree are abundant. No mahogany has been cut except near the larger streams where it could be easily floated out. The rubber industry is limited to the tapping of a few trees easily reached. There are a hundred varieties of fruit that we never see in the States. The fruit is allowed to rot on the ground for the want of a market. Cacao and the vanilla orchid grow wild, and the sarsaparilla vine climbs the tall trees wherever the ground is damp. On this rich bottomland, sugar cane grows nine feet in nine months, in the foot hills there is an abundance of good coffee land and in the high mountains, vast deposits of mineral.

The most difficult feature of construction in this section is the crossing of the numerous small streams which are liable to sudden overflow. A Northern engineer unacquainted with a tropical rainy season would be very apt to locate his line below the high water mark. Wooden bridges and trestles should not be used. No timber fit for bridging will stand the climate, and the *comejen* (white ant) will eat them out almost as fast as they are put in. In Chiapas, and indeed all through Central America, there is very little stone along the route given on the map. In some sections there is none for construction purposes, but bricks are cheap and the lime of the country is equal to Roman cement. The only towns of any importance on the coast of Chiapas are Tonala and Tapachula. The

capital, San Cristobal, is situated in the interior at a high elevation. Considerable coffee is exported from Tapachula through the port of San Bonito. Crossing into Guatemala there is a marked difference in the development of the country. Graded wagon roads take the place of bridle paths. The hills are dotted with coffee estates and the valleys with sugar plantations.

The route runs through the *Finca de Porvenir*, perhaps the largest coffee estate in the world. This estate was the property of President Barrios at the time of his death, and has shipped in a single season 30,000 cwt. of coffee. Not a tenth part of the coffee land of Guetemala is under cultivation, and five years ago one could have obtained all the land he wished, for a mere song, but the present high price of coffee has greatly increased the value of the plantations. Guatemalian coffee is quoted at 24½ cents. The outside cost of production sacked, ready for shipment is 5 cents.

The coffee crop of Central America for 1889, amounted to 1,100,000 cwt., of which the United States obtained 30 per cent. Probably as much sugar is raised, but the profit is small. I am told that this is owing chiefly to the scarcity of labor. The home consumption of sugar is large, a great deal being made into *aguadiente*. A great many dry hides are shipped, and I noticed that the

ON THE PANAMA RAILWAY.

INDIAN WOMAN OF CENTRAL AMERICA.

selected hides went to Hamburg and the culled hides to New York.

The climate of the interior of Central America is as near perfection as any climate on this earth ought to be, all yarns about yellow fever and cholera, to the contrary, notwithstanding. Take the temperature of Guatemala City for instance. Spring, 68.00. Summer, 67.28. Autumn, 99.03. Winter, 63 72 —year, 66.26. John Loyd Stephens, the celebrated traveller of fifty years ago, claimed that the scenery of Central America was finer than anything in Switzerland. Of the many beautiful spots in Central America, I know of none equal to the Lake of Atitlan in Guatemala. I doubt very much if there is a summer or winter resort in the world that has as many natural advantages as this place. Imagine a lake, thirty miles long by ten wide, with a row of five volcanoes, from ten to fifteen thousand feet high, on the one side, and on the other side a table land which ends abruptly, on the shore of the lake, in a perpendicular cliff two thousand feet high. On this table land is the flora of a temperate zone ; on the shore of the lake below, in the bottom of the deep *barrancas*, tropical fruits grow in profusion. I am well aware that I am going against the popular belief, when I make the statement that Central America has a fine climate, but it is a statement that will stand investigation.

The Indians are peaceable and well-behaved if left to themselves,

but the periodical uprisings and revolutions, in which they are called upon to carry a musket for some one or other, whom they know or care nothing about, has a tendency to make them unsettled.

The low lands of the west coast of Central America and Colombia, are well watered, heavily timbered, and fairly well populated. As far as topographical difficulties are concerned, a railroad could be constructed there as easily as in some of our Southern States. There is local traffic enough to support a railroad. At present freight from one of these countries to another must be lightered from the shore to the steamer.—$1.00 per cwt. for general merchandise—pay the heavy local rates of the steamship Company, and pass through the hands of another Pier and Lighterage Company.

Nine-tenths of the European freight for Central America crosses the Isthmus, and comes up the west coast. When the railroad is completed, this freight can be loaded directly from the steamer to the cars in Colon, and carried to its destination. The saving in lighterage alone would pay the freight. The dozen or so Pier

STATUE OF BOLIVAR, LIMA.

VIEW OF LIMA.

Companies on this coast pay from thirty to sixty per cent. dividends. All the railroads now in operation in Central America are earning dividends, and the construction of the Pan American road will give an impetus to the many proposed lines that will be of great help in developing the country. The governments of Spanish America have endeavored to encourage railroad building by giving subsidies and land grants. This has been taken advantage of by the enterprising "Promoter," and many valuable concessions have been hawked about until they have fallen into disrepute.

In Honduras a large amount of capital is being invested in mining. The principal industry of this country is cattle raising. The fruit business on the north coast has increased wonderfully in the last few years. San Salvador, Nicaragua and Costa Rica grow chiefly coffee and sugar. A large business might be developed in indigo, balsam, tobacco, rice, cacao, rubber, gums, hides, mahogany, rosewood, cedar, logwood, dye woods and sarsaparilla.

The Naranjo, Michatoya, Esclavos and Lempa are the only rivers of any size to be crossed in Central America. The principal towns and cities through which the road should pass, are Retalhulen, (to connect with the Champerico R. R.) Matecescuintha, Escuintla, (to cross the Guatemala Central R.R.) Sonsonate, (to connect with

the port of Acajutla), Santa Tecla, San Salvador, San Vicente, San Miguel, La Union (on the Gulf of Fonseca, the most beautiful harbor on the Pacific) Chinandega, Leon, Managua, Grenada and Punta Arenas (to connect with Costa Rica Ry). A line down the west coast would be outside the chain of volcanoes and clear of all spurs from the main range. On the east side the line would have to follow the coast line, which would about double the distance, or else pierce the many ranges of mountains that reach out from the Cordillera. Of these spurs, might be mentioned the ranges of Chamá, Santa Cruz, Las Minas, Merandon, Selaque, Puca, Sulaco, Santa Barbara, Montecillos, Dipilto, Yeluca, Hanpi. The Pacific slope of Central America is more thickly settled and more developed than the Atlantic side.

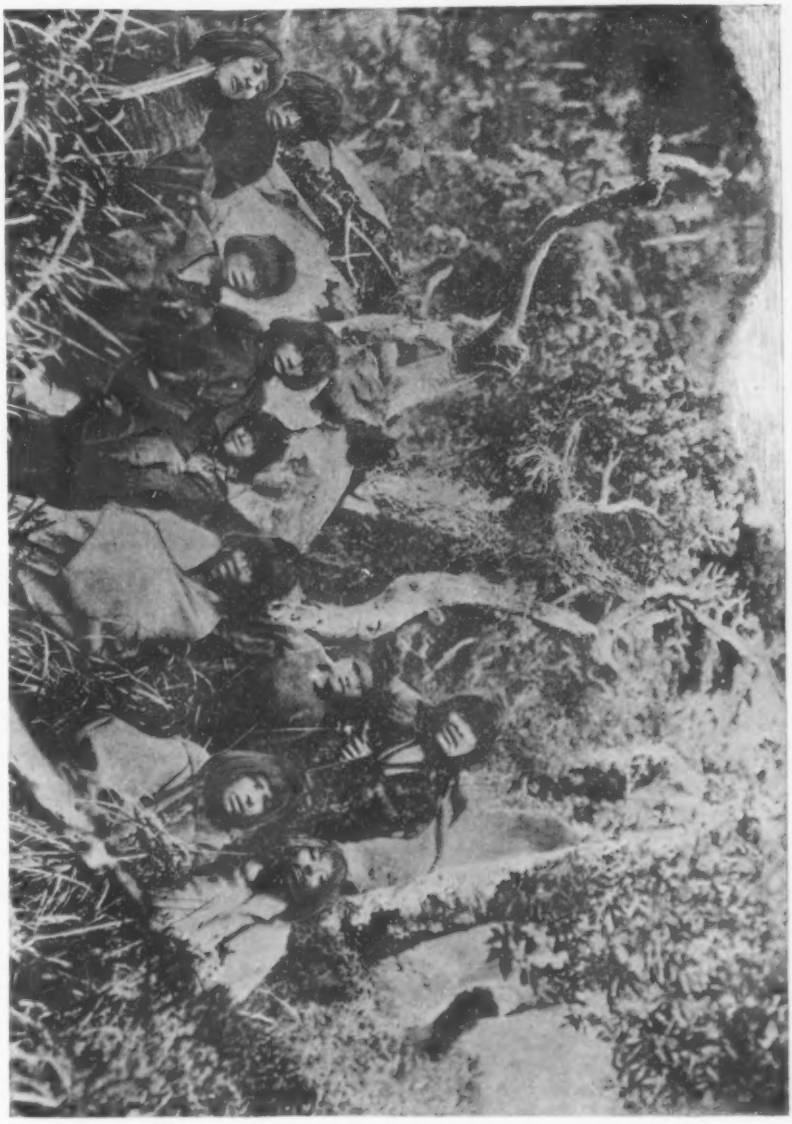
If war does not break out again between Guatemala and San Salvador, both these countries will resume railroad construction. Guatemala is anxious to complete the Northern R. R. from the Atlantic coast to the capital; and the government of San Salvador is to build a line from the port of La Libertad to the city of Salvador. A line to connect Guatemala and San Salvador is talked of. This would be a link in the Pan-American road. In Nicaragua, the existing line could be utilized by the All-American road. In regard to the canal—it is apparently the intention of the management, not to begin actual excavation until the United States guarantees the bonds. In Costa Rica, the completion of the Costa Rica Ry. has opened another transcontinental line.

The west coast of Colombia (south of the isthmus) and Ecuador, is a trackless jungle, and comparatively little is known of its resources.

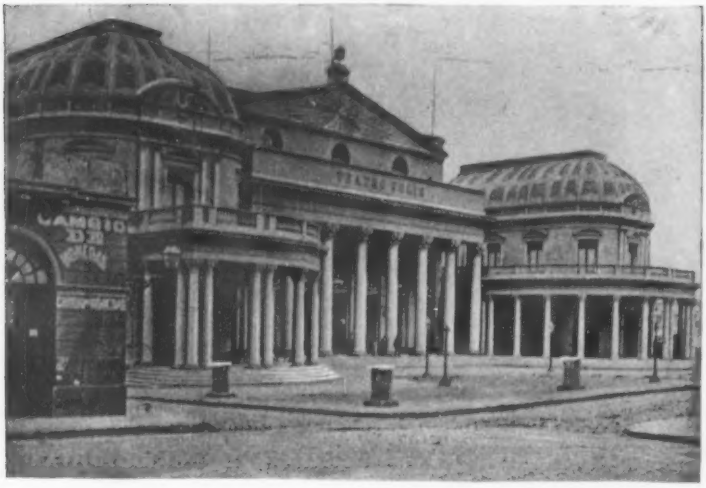
It would not be practicable to reach Bogota and Quito with the main line. Each of these cities has an elevation of about 9000 feet, and although they are located on broad, level plains, yet these plains are shut in by high mountains, and it would be extremely difficult and expensive to locate a line through them with anything like a decent grade. These cities are much nearer the Pacific than the Atlantic side, and could be reached by branch lines. There is a road now being constructed from the port of Buenaventura to Bogota, and from Guayaquil there are thirty miles of track towards Quito.*

Through Peru and down to the connections with the Chilean

*The Guayaquil is the largest river to be crossed. Its width at the city of Guayaquil is about 1000 feet.



ARAUCANIAN INDIANS OF THE SOUTH OF CHILE.



THEATRE AT MONTEVIDEO.

and Argentine railroads the road would do a large local business. That part of Peru between the Andes and the Pacific is much like Arizona, very fertile and productive where it can be irrigated. The market of Lima is one of the finest in the world. Peru ships to Chile, sugar, rum, and fruits in return for wheat and flour. The large nitrate towns on the edge of the desert of Atacama, are entirely dependent on the outside world for supplies, and a railroad would be of great benefit to them. The railroads now in operation in Peru and the northern part of Chile all extend from the coast inland, and will be valuable feeders for the Pan-American railroad.

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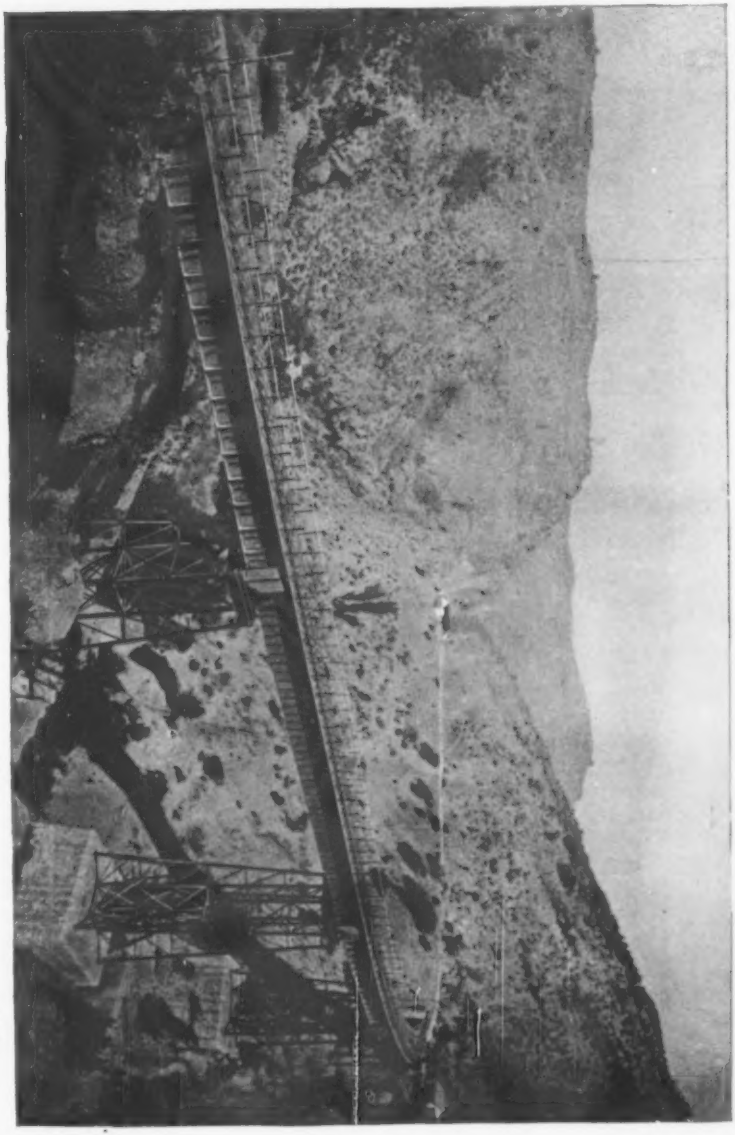
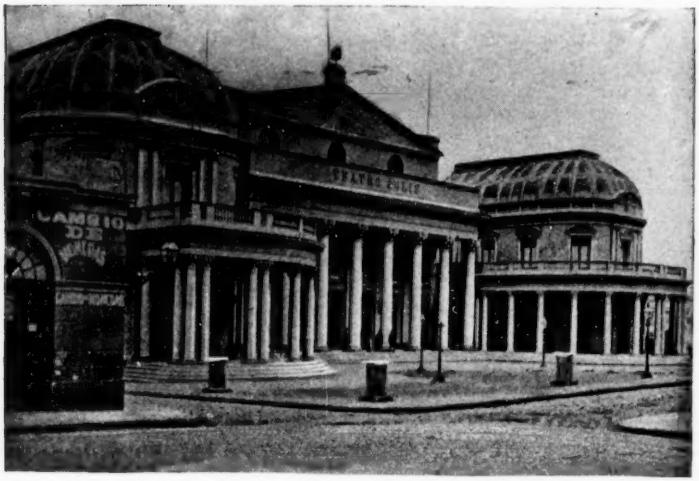


BETWEEN VALPARAISO AND SANTIAGO.



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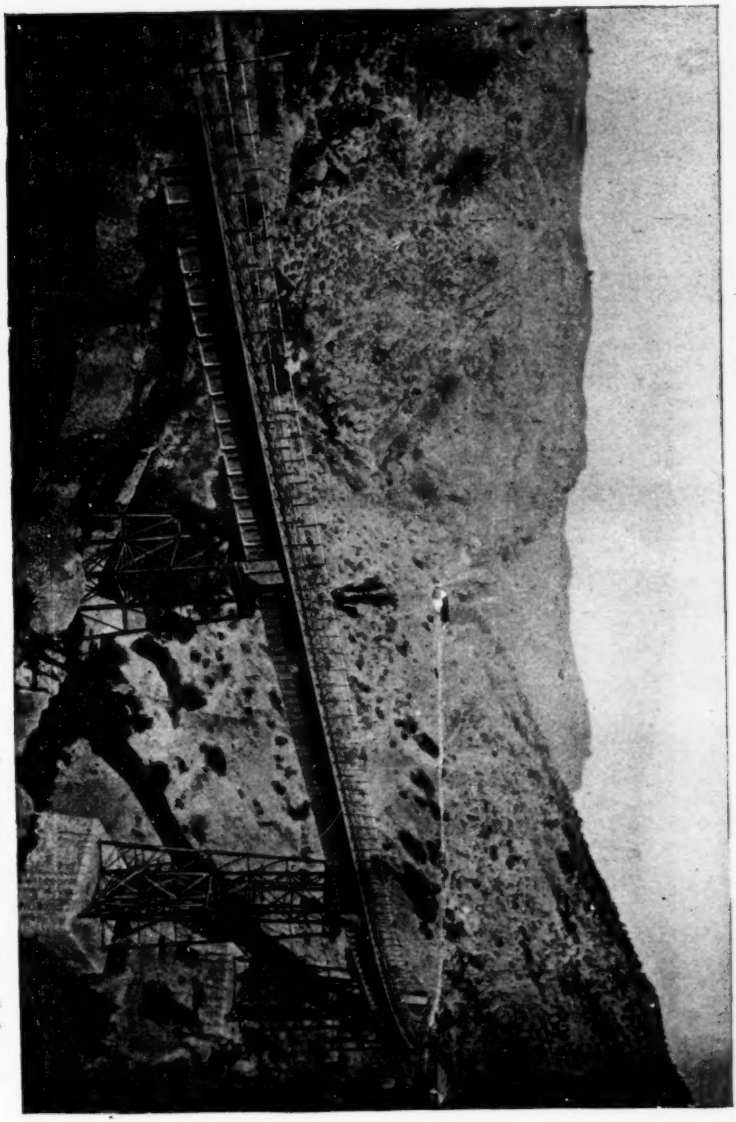
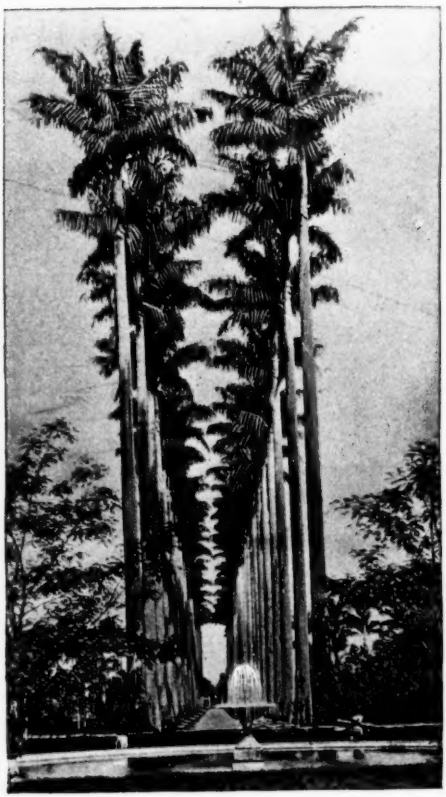


BETWEEN VALPARAISO AND SANTIAGO.

figures contained in this little volume are truthful but not pleasant. European nations have catered to this trade by manufacturing exactly what was wanted. As a general rule the cheapest and poorest grade of goods sell the best. The Indian has but very little money, but that little he will spend for anything that takes his fancy. Forty bladed jack-knives, jews harps, accordeons, harmonicas, concertinas, cast-iron shot-guns and revolvers are staples. There is a great deal of liquor imported. The very best brands of French Cognac, manufactured at Hamburg at $1.50 per case, find ready sale. The custom duties are enormously high, perhaps reciprocity will solve the problem how to obtain the trade of Spanish America.



AVENUE OF PALMS, BOTANICAL GARDENS, RIO, BRAZIL.

At the Isthmus of Panama the Pan-American Railroad should bifurcate. One line to continue down the west side of the Andes and the other to cross Colombia and Venezuela into the upper valley of the Orinoco. The line down the west coast should be constructed first as being the shortest and cheapest way to connect with the 17,000 miles of railroad now in operation. The gaps between the railroad systems of Brazil, the Argentine and

HORTICULTURAL GARDENS, SANTIAGO, CHILE.

Chile are becoming shorter every day, and long before the Pan-American road can be completed these systems will be connected.

The principal objection that can be urged against the construction of this road, is the unsettled state of the country, the frequency with which political misunderstandings are settled with the bayonet. If these countries were joined to each other and to the United States by rail, I think the troubles would cease. Mexico, since the building of the railroads and the consequent introduction of a large amount of foreign capital, has had no revolution. An insurrection in one of these countries would of course affect traffic, but the destruction of the road would not necessarily follow.

The International American Conference recommend "that the railroad should be declared forever neutral for the purpose of securing freedom of traffic," and also that "the neutrality of the road, and the free passage of merchandise in transit, should be the subject of special agreement between all the nations interested." Under these conditions the people who invest in this road would have ample protection. The different republics through which the road must run have all expressed their willingness to give subsidies and land grants. I cannot truthfully affirm that these subsidies are always "gilt-edge" security, but it

is quite certain that these governments will do all in their power to aid the contemplated road.

This road is bound to come in time, even without preconcerted action, and I am of the opinion that it would be as well to build it with American money and make it a Pan-American railroad in something more than name. Some of the interested countries are already sending to Europe to raise capital to build their portion of the line. If the United States has designs on the Spanish American trade it will not be wise to have the Inter-Continental railroad controlled by European capital.

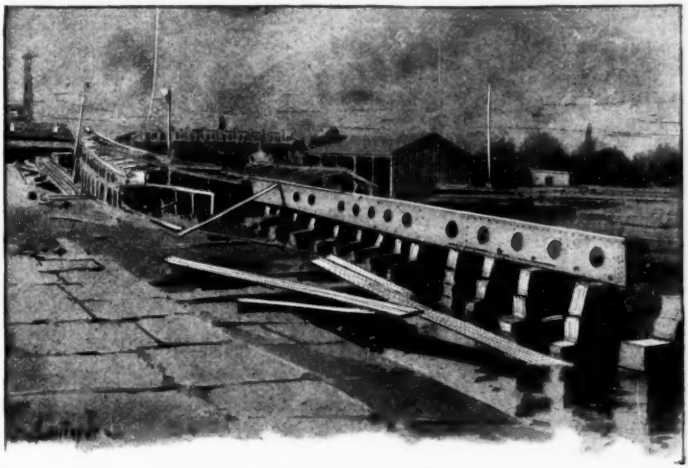
BUILDING THE STEAMSHIP IN AMERICA.

IV.—SHIP-YARDS.

By Horace See, E. and N. A.

PREVIOUS to 1844 all of the steamships built in this country were constructed of wood, and in yards which did not possess facilities for working in any other material. Iron was first used in the construction of small vessels principally for river service. The parties who engaged in this enterprise were builders of engines and boilers. Their capital was not large, and consequently their facilities were quite limited at first. The encouragement they received was also not very satisfactory, as the greater first cost, coupled with the false idea that more speed could be obtained from a wooden vessel than from an iron one, held owners firmly to the use of wood. The starters of the pioneer ship-yards, however, stuck to the business and to-day are among the most flourishing in the land.

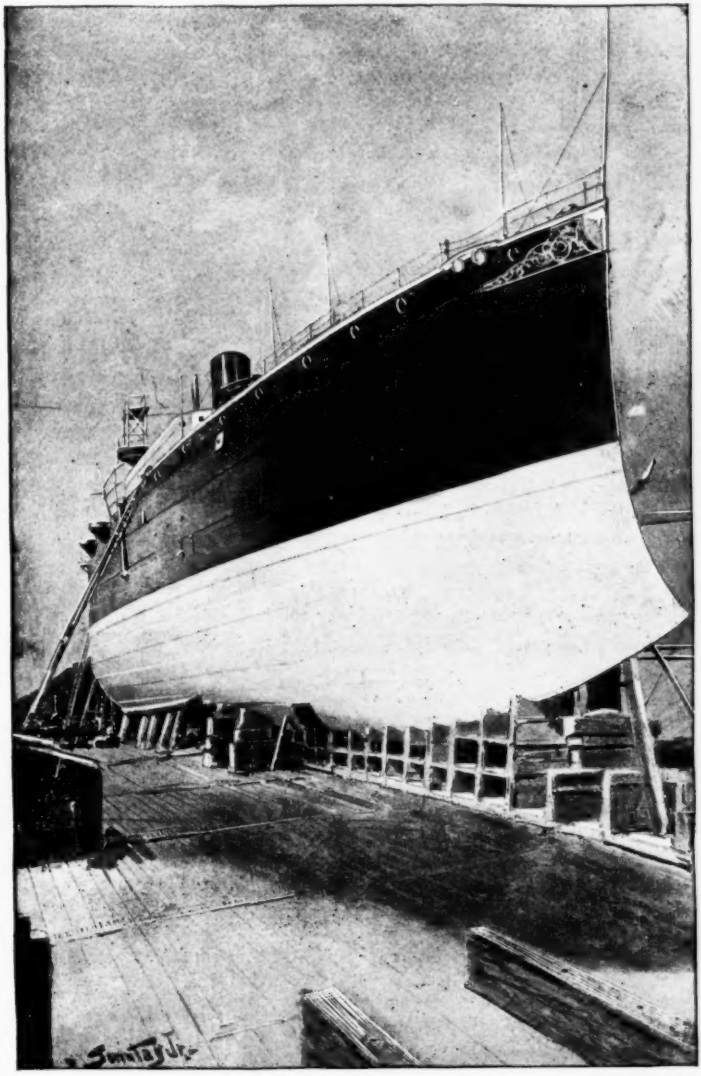
Messrs. Neafie & Levy and Harlan & Hollingsworth began to



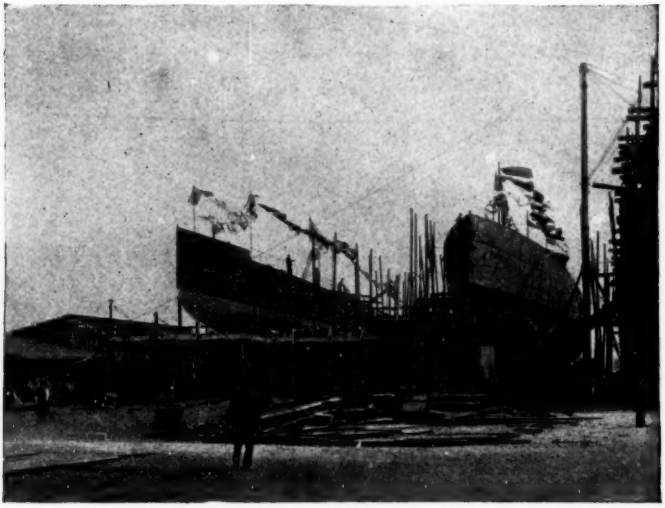
U. S. ARMORED BATTLE-SHIP TEXAS, NORFOLK NAVY-YARD, 1889.

build iron vessels about the same time, although the latter concern engaged in business about five years previous to the former. The ship-yard of the Neafie & Levy Co. started in 1838 by Reaney, Neafie & Co. as the Penn Works, is situated at Philadelphia, on the Delaware, where it occupies about eight acres at the foot of Norris Street. Their business has not been confined to ship-building alone. They would have failed if they had been dependent upon this branch. They were the first concern to build screw-propeller engines. These were fitted to wooden as well as to iron vessels. They built the machinery for the U. S. sloops of war, *Lancaster* and *Pawnee*, as well as those for the large coastwise merchant steamers of the sixties. Their plant consists of ship-yard, smith, machine pattern and boiler shops, iron and brass foundry, and railway capable of hauling out vessels of about 1000 tons. Although their work has been largely in the line of screw-propellers they have built quite a number of side-wheel boats and engines. During the Rebellion this firm built no vessels directly for the Government, their whole plant being engaged on private work. One of their late productions, the *Charlotte*, built in 1889, for the Baltimore, Chesapeake and Richmond Steamboat Company has been a very successful boat. She is 229 ft. 8 inches long, 38 ft. beam, 23 ft. 2 inches depth and a tonnage of 1747. She is propelled by a single vertical direct acting triple expansion screw propeller engine with cylinders 21, 31 and 55 inches diameter, by 36 inches stroke of piston at a speed of about 14 knots. They are now building a magnificent steel steam yacht for Mr. J. Pierpont Morgan, which is intended for very high speed as well as extreme comfort. She has been launched and is now receiving her machinery, as well as general outfit. Her length is 238 feet over all; 204 feet on load line, beam 27 feet, depth 18 feet moulded. The finished draught is to be about 10 feet. She has a bar keel and is fitted with four water-tight bulkheads. She will be driven by a single vertical screw-propeller engine, having cylinders 21, 32 and 54 inches diameter, by 30 inches stroke of piston. There will be two single ended, internally fired boilers, 14½ feet diameter by 11 feet long working in plenum.

The Harlan & Hollingsworth Company, established in 1833, began the business of iron ship-building at Wilmington, Delaware, about the same time as Messrs. Neafie & Levy, their first vessel, the *Bangor*, being built in 1844. They have extensive water-front on the Christiana. Although their first vessels were screw-propellers, the bulk of their business, until a recent date, has been



U. S. S. CHARLESTON, IN DOCK AT UNION IRON WORKS.



U. S. GUNBOAT YORKTOWN AND DYNAMITE CRUISER VESUVIUS ON THE STOCKS.

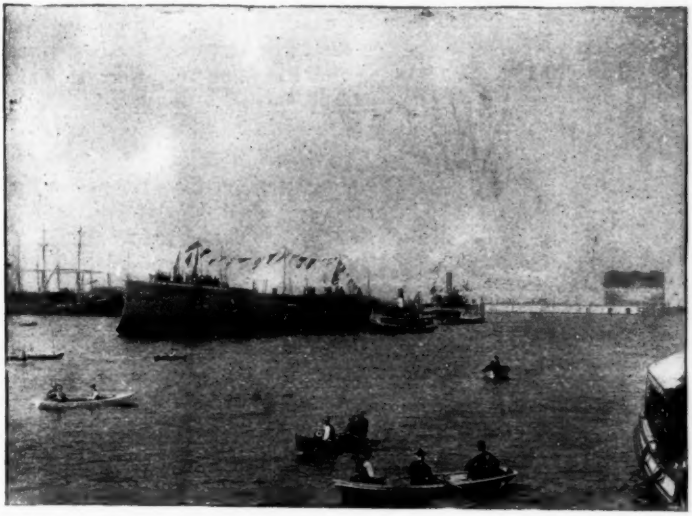
in side-wheelers. Tug-boats, ferry-boats, yachts and merchant vessels are included in their list; the largest vessel being the *Excelsior*, of the Morgan Line, of 3264 tons. They also built the yacht *Alva* for Mr. W. H. Vanderbilt, a magnificent single screw vessel of 1151 tons, with a length of 256 feet, a beam of 32½ feet and a depth of 18½ feet. They also built the side-wheel boat *New York*, of the Albany day line; the twin screw boat *Sandy Hook*, of the New Jersey Central R. R.; the single screw boats *Washington* and *Norfolk*, of the Washington and Norfolk Steamboat Company, and a large number of other vessels of all sizes. They have complete facilities for fitting out the entire vessel, being equipped with ship-yard, machine, boiler, pattern, smith and joiner shops and foundry. A Simpson Dock, capable of docking vessels 340 feet in length, is also located on their property. They are also extensive builders of all sorts of railroad cars.

In the neighborhood of Harlan and Hollingsworth is located the establishment of Pusey, Jones & Co., who built their first vessel, a wooden side-wheeler, in 1851. Their first iron vessel, also a side-wheeler, was built in 1853. This company, unlike the others above mentioned, did not confine themselves to the building of

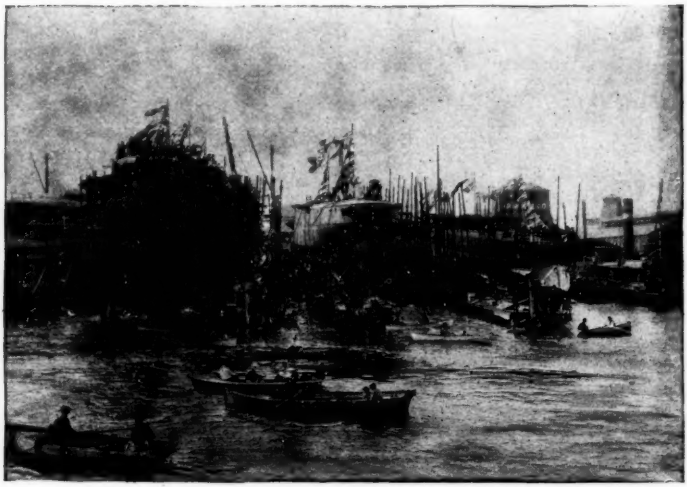
vessels of one kind of material, but have used both wood and iron until quite recently. Their customers have largely come from the countries south of us—Mexico, Brazil, Ecuador, etc. They have turned out as high as eighteen vessels, some of which were 150 feet long, in one year.

The two principal towns on the Delaware being closer to the iron producing section of the East were naturally the first to have the iron ship built in their midst. New York was skipped in the development which made Boston the next point to build iron vessels. The Atlantic Works, East Boston, were established in 1853. Their first vessel was the *Voyageur de la Mer*, already described. During the Rebellion they were actively engaged in building vessels for the United States Navy. The Monitors *Nantucket* and *Casco* were built here. They also constructed the machinery for many others. Mr. Harrison Loring, of Boston, began iron ship-building in the sixties. At his yard quite a number of vessels were made during the Rebellion, but the works afterwards became quiet. He is now building Cruiser No. 11.

The ship-yard of the Delaware Ship Building Company was originally started by Messrs. Reaney, Son & Archibold on the re-



U. S. GUNBOAT YORKTOWN AFTER LAUNCHING.



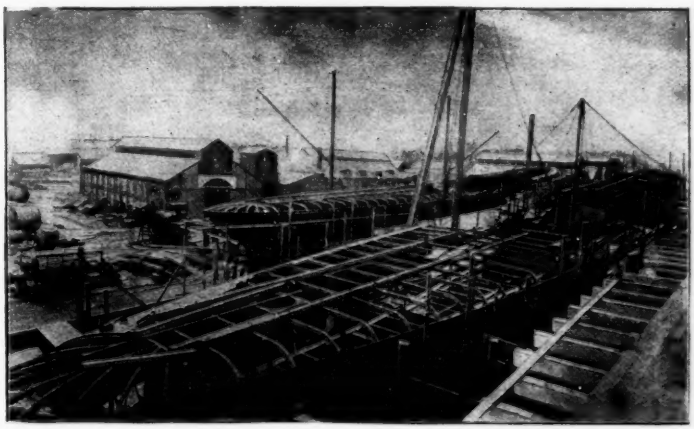
U. S. GUNBOAT YORKTOWN AND DYNAMITE CRUISER VESUVIUS, ON THE STOCKS BEFORE LAUNCHING AT CRAMP'S SHIP-YARD.

tirement of Mr. Reaney from the Penn Works about the year 1859. These extensive works are located at Chester, about sixteen miles south of Philadelphia. During the Rebellion they were actively engaged in building monitors, double enders, transports, etc. Mr. John Roach took possession in 1871. The yard has a frontage on the Delaware of 2500 feet. The vessels built at this yard have been, with a few exceptions, of the largest class constructed in the country. Included in the list are the United States monitors *Miantonomah* and *Puritan;* cruisers *Chicago*, *Boston*, *Atlanta*, and *Dolphin;* the merchant steamers *City of Peking*, *Louisiana*, *Newport*, *Kansas City*, etc.; the Sound steamers *Puritan*, *Pilgrim* and *Plymouth;* and a large number of others.

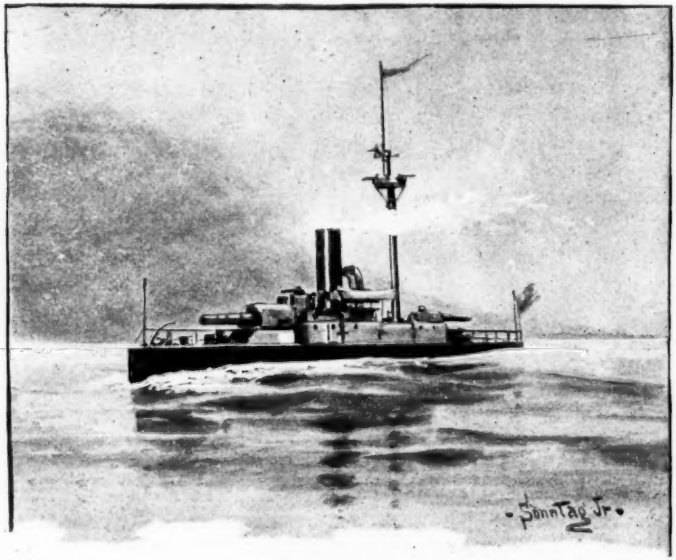
The Bath Iron Works, of Bath, Maine, a yard of new creation, have gone largely into the construction of naval vessels, and are now building the Harbor Defense Ram of 2000 tons, and Gunboats 5 and 6 of 1050 tons. They were the lowest bidders on Cruiser No. 13 of 7400 tons, but have not yet been awarded the contract. The Wm. Cramp Sons Co. of Philadelphia, established in 1830, did not build an iron vessel until 1863. It was not until 1871 that the machinery, as well as the hull, was built by them. The *Geo. W. Clyde*, the first

of this series, was built in the old yard at the foot of Norris Street, where the dry dock is now located. This dock is 460 feet long, 111 feet wide, and with 20 feet of water on 3 feet blocks. The vessels which succeeded the *Geo. W. Clyde* were built at the foot of Norris Street. The property which has been gradually acquired at this point has now a frontage of some 1200 feet on the Delaware. Their entire plant is now employed on large contracts for Government vessels. The vessels of the new navy constructed by them have been eminently successful. These include the *Baltimore*, *Philadelphia*, *Newark*, *Yorktown* and *Vesuvius*. The vessels of the original American Line were built by them, as were also the six 1500 ton Reading colliers ; the cruisers *Europe*, *Asia* and *Zabiaka* of the Russian navy ; the *Mariposa*, *Almeda*, *State of California*, *Queen of the Pacific*, etc., now on the Pacific ; the *Caracas*, *Chalmette*, *El Monte*, *El Mar*, *El Sol*, *Olivette*, *H. M. Whitney*, etc., on the Atlantic ; the yachts *Atlanta*, *Corsair*, *Stranger* and *Peerless*, and the twin screw Sandy Hook passenger steamer *Monmouth*.

The building of iron ships on the lakes, which now has assumed such large proportions, did not begin until 1872. The first plant was established by Mr. E. B. Ward in that year at Wyandotte, sixteen miles below Detroit. It was not a success, owing to the same difficulties which were encountered in the early days of iron shipbuilding on the Atlantic sea-board. The plant was purchased in



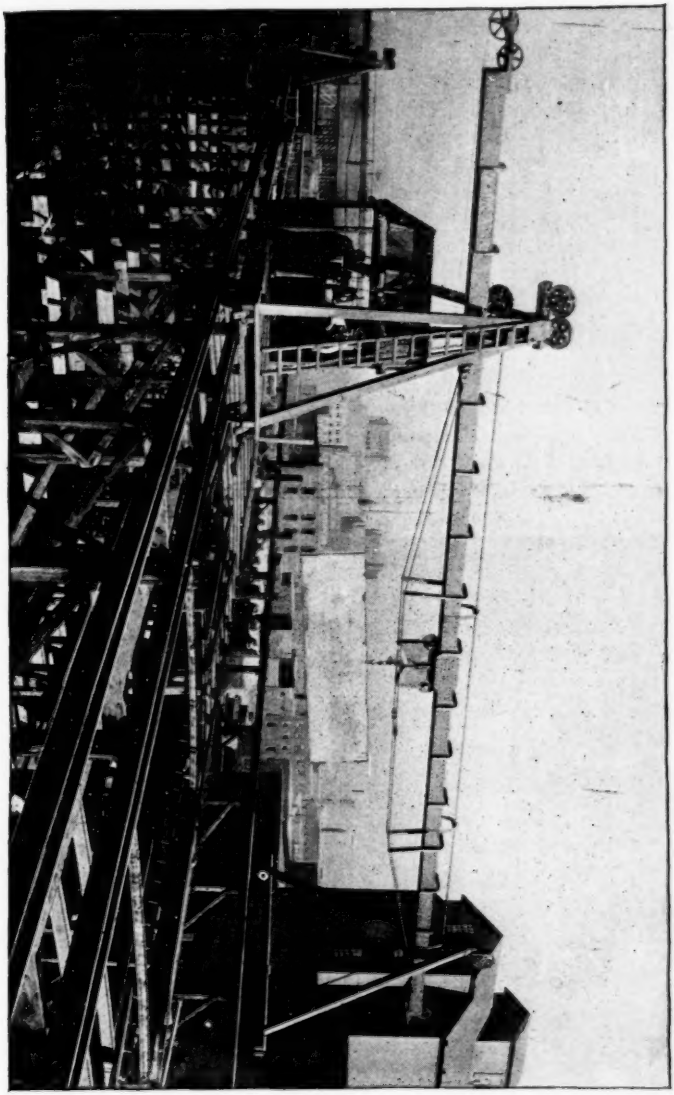
U. S. S. BENNINGTON AND CONCORD, ON THE STOCKS AT DELAWARE RIVER IRON WORKS.



COAST DEFENSE VESSEL.

1879 by the Detroit Dry Dock Company, who, with patience and by judicious management have established a large and profitable business. The yard has 700 feet frontage and covers seven acres. The vessels in this, as well as in all of the yards on the lakes, are built parallel to the body of water into which they are to be launched, and then dropped broadside into it. The *Harlem*, previously described, and her sister ship, the *Hudson*, were built here, as was also the *Maryland*, belonging to the Inter-Ocean Transportation Company. This vessel is 316 feet keel, 42 feet beam, 24 feet depth, and has actually carried 3322 tons of ore. She is equipped with a splendid electric lighting plant of 400 lights. This yard has built some of the largest and most successful boats on the lakes.

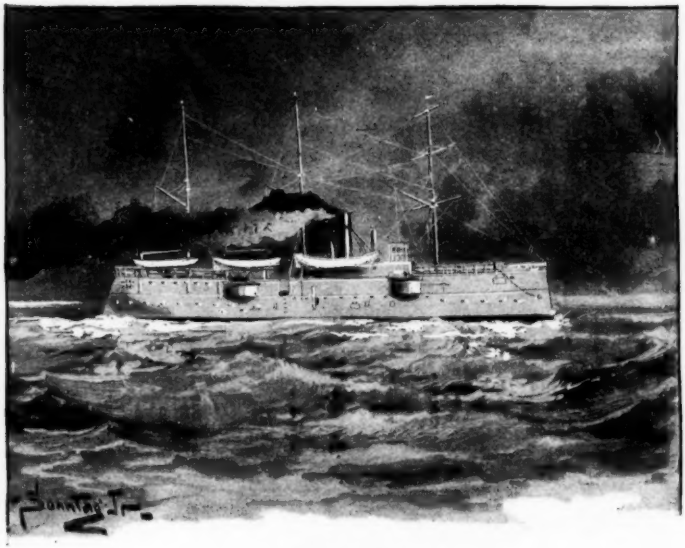
The development of iron ship-building on the lakes contains many a lesson for the shipbuilder on the Atlantic. Young, enterprising, and free from the traditions of the past, the yards have introduced new labor-saving appliances which have enabled them to cut down the cost of production. One of the most notable of these



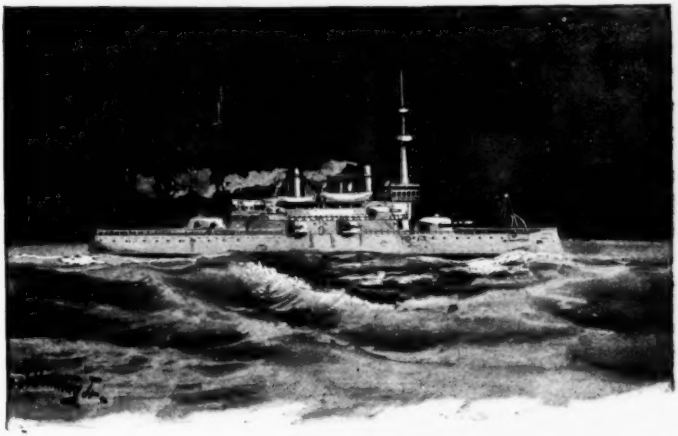
TRAVELLING CRANE AT THE CLEVELAND SHIP BUILDING CO.'S YARD.

has been that for handling material. The extent to which this has been carried is shown in the yard of Mr. F. G. Wheeler, who began iron shipbuilding in 1888. This yard has a frontage of 3500 feet on the Saginaw River, at Bay City, Michigan, and contains 40 acres. The total length of the shops which contain the iron and steel plant is 1000 feet, located about 130 feet from the water's edge. A steam travelling crane of 10,000 lbs. capacity runs along their entire length. It is a cantilever which reaches from the shops to the water's edge, with the outer arm extending over the full width of the vessel. From the engine-house on the crane all of the movements are manipulated by one man, so that all of the material is taken from the shops, and quickly transferred to any part of the vessel. Hoisting engines for independent handling of work, are established at every desirable point in the yard.

It will not do to neglect mentioning the Globe Iron Works, and the Cleveland Shipbuilding Company, both of Cleveland, the Union Dry Dock Company of Buffalo, the Chicago Shipbuilding Company of Chicago, and the Duluth Shipbuilding Company, managed by Captain McDougall, as forming part of the great concerns



PRACTICE CRUISER.



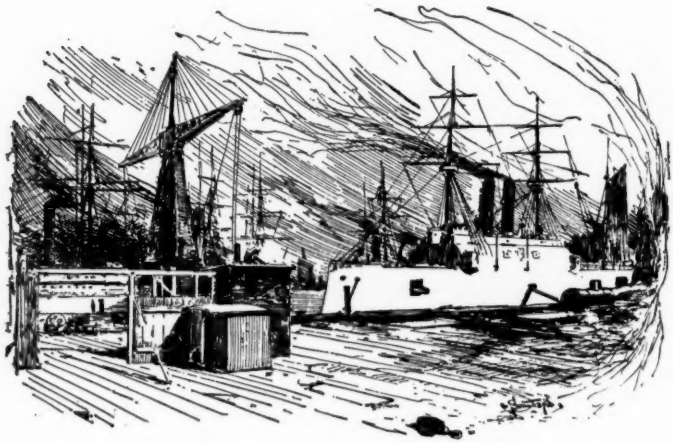
COAST LINE BATTLE SHIPS, NOS. 1, 2 AND 3.

which have had so much to do in rapidly building the immense fleet of lake steamers. The lakes have been highly favored in having a sufficient number of yards to keep the business in such a healthy state that the owner of vessel property, when he desired to build, could be accommodated at a price which would permit him to order the vessel and not frighten him away.

The Union Iron Works of San Francisco, which had acquired a high reputation for the construction of mining and other machinery, having added a ship-yard to their extensive plant, came forward when Mr. Whitney asked for bids on the unarmored ships and secured the contract for the *Charleston*. This vessel and the *San Francisco*, which they afterwards secured, have been finished and tried with very satisfactory results. It has thus been demonstrated that the Pacific Coast can be relied upon to produce ships of the highest character. The yard is fitted out with labor-saving appliances of all kinds, including travelling cranes over the vessels for handling the material entering into their construction. A hydraulic lifting dock also forms part of the general equipment of the yard. They have now under construction for the Government the monitor *Monterey* of 4003 tons, the battle ship *Oregon* of 10,298 tons, and the unarmored cruiser No. 6 of 5500 tons.

The latest development in a plant for building steamships is to

be seen in the colossal yard of the Newport News Shipbuilding and Dry Dock Company projected by Mr. C. P. Huntington at Newport News, Virginia. Located in the finest harbor in the world it has a frontage of about 2200 feet on the James River. It contains about 70 acres, and is equipped with buildings which cover over 5 acres. The buildings, piers, shipways, etc., have been arranged so that the lifting and moving of all material is done in the cheapest and most expeditious manner. The improvements are of the most substantial character, iron and brick being mostly used in the construction of the buildings, and every known appliance introduced that will rapidly produce cheap and superior work



THE ATLANTA AT THE DOCK OF THE MORGAN IRON WORKS.

of the largest and heaviest kind. A timber dry dock 600 feet long on top, 130 feet wide on top, 50 feet wide on bottom, 90 feet wide at entrance, and with a draft of 25 feet over sill forms part of the plant. A marine railway capable of hauling out a two thousand ton vessel is also to be constructed.

Amongst the buildings are a three-story office and general storeroom 40x200 feet, stable 40x60 feet; a three-story pattern and joiner shop 60x300 feet; a machine shop with one main bay 50x300 feet, and two two-story side bays of 25x300 feet each; boiler shop with two bays 50x300 feet each; blacksmith shop with two bays 50x300 feet each; bending shed 60x127 feet; a two-

story ship shed and mould loft 60x300 feet ; also shipfitter's shop, beam shed, lumber sheds, paint shop, rigging loft, timekeeper's house, etc. A power house of brick, 40x130 feet, contains boilers, pumps and accumulators for the hydraulic plant, dynamos, heating plant, etc. The shipways are to be eight in number, four of which are completed, and will range from 400 to 500 in length. The piers are as follows : one 60x900 feet long, one 60x350 feet, one 80x350 feet, one 60x550 feet, and one outfitting basin 900x500 feet. Two vessels of 4500 tons are now upon the stocks. These are the *El Sud* and *El Norte*, building for the Morgan Line of the Southern Pacific Railroad Company. They are 406 feet long, 48 feet beam, and 33¾ feet depth. A cantilever crane travels over these vessels to carry the frames and other material from the inland ends of the ways to its place in the vessel. The climatic conditions at Newport News are very favorable for outside work, as ice and snow do not interfere with it in winter.

The Chesapeake bay and its estuaries are looming up as favorable locations for ship building. The Columbian Iron Works at Baltimore include a good yard and a large timber dock. The gunboat *Petrel*, of 870 tons, of the new navy, was built here, and Cruiser No. 9 and 10 of 2000 tons are now under construction. The Pennsylvania Steel Company have built a very large and well-equipped yard on its property at Sparrow's Point, some ten miles below Baltimore, in connection with its large steel-producing plant. They are at present building a couple of small vessels and contemplate building the ships they need for the transportation of the foreign ore used by them, as well as any other work which may offer.

With the increased facilities which have been created in the past two or three years, the prospect for a still higher development of the art in this country is very promising.

WHAT IS THE USE OF A BUILDING LAW?

By John Beverley Robinson.

TO impugn the utility of any law is just now a delicate and thankless task. The blind deference that in the past was displayed to ecclesiastical rules, has in our day, lacking better things to worship, been transferred to the civil law. Our State-directed schools, as was inevitable, have become the nurseries of political superstitions, which display themselves in our Fourth-of-July self-gratulations and in the total unconsciousness, in ordinary minds, that anything better than our political arrangements can by any possibility evolve from present conditions. To these, there is no higher test of right than the vote of a legislature. That the majority can do no wrong, is as firmly grounded in their faith as was in the mediæval mind the doctrine that the king can do no wrong. With them, to obey the law is the chief virtue. They have lost the sense of virtue that demands disobedience to law, where the instinctive sentiment of justice is not satisfied.

Yet a few are beginning to ask: What is the limit, in reason, to this power of the majority? Is it true that the majority has a right to force us—the minority—to anything it may please? If not, what is the limit to its authority? And the answer comes from the chief of the philosophers of recent years,—with all his faults, the prophet of the future, Herbert Spencer:

"'No human laws are of any validity if contrary to the law of nature; and such of them as are valid, derive all their force and all their authority mediately or immediately from this original.' Thus writes Blackstone, to whom let all honor be given for having so far outseen the ideas of his time; and indeed we may say of our time.

"A good antidote, this, for those political superstitions which so widely prevail. A good check upon that sentiment of power-worship which still misleads us by magnifying the prerogatives of constitutional governments as it once did those of monarchs. Let men learn that a legislature is *not* 'our God upon earth,' though, by the authority they ascribe to it and the things they expect from it, they would seem to think it is. Let them learn rather that it is an institution serving a purely temporary purpose, whose power, when not stolen, is at the best borrowed." (*Social Statics*, p. 229.)

After a page or two devoted to pointing out the unavoidable

final abolition of government, and the contradictions and absurdities involved in its present temporary existence, he continues:

"Of the political superstitions lately alluded to, none is so universally diffused as the notion that majorities are omnipotent. Under the impression that the preservation of order will ever require power to be wielded by some party, the moral sense of our time feels that such power cannot rightly be conferred on any but the largest moiety of society.

"It interprets literally the saying that 'the voice of the people is the voice of God,' and transferring to the one the sacredness attached to the other, it concludes that from the will of the people, that is of the majority, there can be no appeal. Yet this belief is entirely erroneous."

It is not my purpose to criticise present laws; but rather to deny the right of anybody,—of any majority, to undertake the control of the details of construction, or indeed to enforce any requirements, save possibly the barest and simplest for the avoidance of what manifestly threatens impending danger. Most cities have their building laws, and have suffered the ill effects of such short-sighted legislation. The subject presented for review is, therefore, so wide in its range that the limits of a magazine article require me to confine my observations to some one locality. Let us then note some of the points in the New York building law which are open to criticism.

The opening paragraphs lay down a series of rules for the various thicknesses of walls, which are, to say the least, inflexible and excessive. Moreover, they rarely touch the really critical points at all: the width of the piers between the openings. Provided your wall is as thick as the law requires, the amount of solid may be attenuated in the other direction without exciting comment. To substitute skilful arrangement for dead weight of masonry is sternly repressed by the provisions that hollow walls, or walls built with buttresses, must have the same amount of materials as straight walls; reducing those who wish to save material to the alternative of perforating the wall with many flues, or of filling the interior of the wall with sand, as one enterprising builder did.

Take again the requirement of bondstones, as they are called, in piers of a certain size, although the weight of opinion is that the pier is weakened rather than strengthened by the presence of bondstones. In the past the law required the use of bondstones in walls as well as in piers; and in old buildings strings of bondstones may be seen, serving no purpose but to render the wall less homogenous and more liable to crack at that point. This provision, with others

requiring the use of bluestone, was long retained by the power of the bluestone dealers. Previous to that the law recognized and permitted the use of bond timbers in walls, a practice which has fallen into disuse from its inherent viciousness, but without discountenance while it continued from the law.

So, still, the custom of veneering the fronts of buildings with a thin scale of stone is recognized by the law of to-day, and the method for doing so is laid down simply confirming the usual practice; but the only method that can be called constructive, that by which the stone facing is bonded into and made a part of the wall, the devisers of the law seem never to have heard of.

One of the delusions of the law is the demand that all iron work shall be tested. What more reasonable, thinks the ordinary citizen, when cast-iron is known to be often affected by flaws than to make a law that it shall be tested? While we are about it, let us extend the law to cover the testing of wrought iron, too. Actually what does it amount to? There is not a machine on earth, nor is it practicable to apply a load, that will test a large iron girder or column, scarcely even a small one. The only testing machine used by the inspector is a small piece of chalk, wherewith, having calculated the strength by an unintelligible formula, he chalks the lintel or beam in question.

Many provisions of the law are simply superfluous, or related to matters which no inspector could control without being on the spot all the time. Among the first is the amusingly solemn paragraph to the effect that all floor beams shall be suited to the weight they have to sustain. In practice such a loose provision gives opportunity for tyranny and corruption. Even where these do not occur the strength required will depend upon the affability of the superindent, perhaps upon the Welsh rarebit he had for supper.

The laying down of minute proportions of lime and cement in mortar is equally deceptive. Nobody can tell but in the most general way whether such instructions are complied with or not, unless he watches every shovelful that is mixed. As for the prescription of quality it is almost as useless. One contractor that I happen to know of kept a load or two of very good sand in front of the building, much to the gratification of the inspector, while the work was built with the most indescribably bad mixture of dust and vegetable mould, openly used for mortar in a pen at the rear of the lot.

Probably the crowning absurdity of the law is that part which orders a brick wall to be built around all elevators. Here again

nothing could seem more reasonable to the people who are not intimately acquainted with details. A brick elevator shaft is supposed to act as a chimney and to conduct fire and smoke harmlessly out, through the skylight on top. Really, the necessary openings on each story, in spite of alleged fireproof doors, serve to conduct the flames, fanned to furnace heat by the draft of the brick-shaft, to each story of the building at the same moment. So great is the heat generated by the chimney-like shaft, that quite recently a fire was communicated to adjoining premises through an apparently perfect brick wall. A series of hatchways offers no such advantage to the fire, but permits it to be confined, for a while at least, to the story where it starts. Especially ridiculous is this demand for a brick wall about elevators when no such wall is required for hoistways. That is to say, you may hoist a barrel through trap doors by hooking it on the end of a rope; but if you hook a platform on the rope, and put the barrel on the platform you must build a brick shaft to hoist it in. I do not insist much upon such criticisms. What I do insist upon is the utter impossibility of framing any statute that can cover the multitudinous, complicated, various and ever-changing conditions of building operations.

Few people have any conception of the inventiveness that is required in all mechanical operations. From the village carpenter to the engineer, all are occupied with continually new problems, for which new solutions must be found.

For the architect not least is this inventiveness required. Indeed, more than most technical workers the architect must be an inventor, because he is called upon to solve, not only problems of construction, but continually to devise new designs to be constructed, of which the value is largely that they are new. The fundamental objection to such statute law is, that it hinders this process of invention and thereby necessarily retards progress in the art of building. The more perfect the law the more perfectly does it accomplish this result. An ideally perfect law would at once put an end to all progress, and render the possession of intellect an injury rather than an advantage to architects. The most that a law can do is to perpetuate the best known existing methods. In a few years of normal progress these would become obsolete. To give discretion to the authorities is virtually to place legislation in the hands of individuals; not to give them discretion makes it more and more difficult to modify the law. Ideal perfection has

fortunately not yet been attained in the general building law. In the matter of plumbing, which is in charge of the Board of Health, with its autocratic powers, the regulations may be regarded as ideal. It is a mere waste of time nowadays for an architect to reflect upon the best method of doing the plumbing of a building; it is for him to ask humbly what the authorities will deign to prescribe. The law, as it stands, requires extravagantly costly plumbing, and has the earnest support of all of the ablest and most conscientious plumbers.

The converse side of this disparagement of high capacity and discouragement of new ideas, which the law necessarily involves, is the direct support to incapacity which the law affords. Many a man practices architecture on the strength of his permit from the Department of Buildings, when, not to speak of his client's lack of confidence in him, his own knowledge of his weakness and fear of taking the responsibility involved would deter him from doing so, were it not for the false assurance conveyed to one and the false confidence to the other by the official seal. This function of bolstering up those whom natural selection would weed out, is sufficient in itself to condemn the law.

A very extraordinary instance of this process of the restriction by law of the competent and fortification by law of the incompetent is going on in Chicago. They have been building there a very remarkable series of buildings of excessive height, eighteen or twenty stories. These buildings have been constructed on an entirely new principle: a steel frame with a mere skin of masonry. They are put up with extraordinary rapidity and at comparatively small proportionate cost. In the grade of engineering ability required they are on a par with the big bridges and tunnels that engineers do. It would seem that the men who have thus successfully struck out a new line and successfully completed such buildings should be competent to do more of the same thing. Yet a proposal is on foot for the governmental regulation of such buildings. Especially does this seem grotesque when it is remembered that of all the large buildings in Chicago all are successful but the Government building recently completed: *that* is reported to be settling continuously and disastrously in spite of the millions lavished upon it.

To turn for a moment to the frequently advanced criticism, not only of the building laws, but of the excise and many other laws that attempt to control actions which mankind does not generally rank as criminal,—the fostering of underhand evasion and cor-

ruption. It would be possible for any one who was interested in doing so to collect a very startling list of the deliberate violations of the building law that occur every day.

It is a delicate matter with most people to charge evasion of the building law. As for myself, I regard such evasion as a virtue, and a charge to that effect from me is an encomium. Apart from proof —proof I cannot offer ; I am not the one to tell tales out of school— it is an inevitable inference that evasion must occur, whether accompanied by corruption or not. In point of fact it occurs in both ways. To obtain a permit and to build a building in accordance with it, are two very different matters ; and it is usually far easier to make any required concessions to get a permit, and then arrange to build the building as you please afterward, than to delay matters by trying to get a permit in the first place for every little thing you want to do. Corruption exists, but they who know the ropes rarely find it necessary to resort to it ; besides its cost is to be avoided if possible.

At the bottom, we must dwell upon the fact that the popular opinion upon which the building law is based, is a mistaken opinion. This opinion is that people will not build well unless they are compelled to. The truth is that, while building laws impede progress, they do not advance the customary grade of work a single degree. It is the customary standard of work that is always made into law. If it were not customary it could not be enforced and is not enforced. What is customary and generally recognized as safe will be carried out as well without the aid of a law.

The old common law—the unwritten law of public opinion— which every transgression makes self-evident, and which all people instinctively respect and obey, is all-sufficient for all cases. Every attempt to make a statute law that will fit the ever-changing conditions is, in the nature of things, an impossibility.

"But why cite individual cases? * * * * What is the statute-book but a record of such unhappy guesses? or history but a narrative of their unsuccessful issues? And what forwarder are we now? Is not our government as busy still as though the work of law-making commenced but yesterday? Has it made any apparent progress towards a final settlements of social arrangements? Does it not rather each year entangle itself still further in the web of legislation, confounding the already heterogeneous mass of enactments into still greater confusion? Nearly every parliamentary proceeding is a tacit confession of incompetency. There is scarcely a bill introduced but is entitled 'An Act to amend an Act.' The 'Whereas' of almost every preamble heralds an account of the

miscarriage of previous legislation. Alteration, explanation and repeal, form the staple employment of every session. All our great agitations are for the abolition of institutions purporting to be for the public good. The history of one scheme is the history of all. First comes enactment, then probation, then failure; next an amendment and another failure; and, after many alternate tinkerings and abortive trials, arrives at length repeal, followed by the substitution of some fresh plan, doomed to run the same course, and share a like fate." (*Social Statics*, p. 21.)

"'It is a gross delusion to believe in the sovereign power of political machinery,' says M. Guizot. True: and it is not only a gross delusion, but a very dangerous one. Give a child exaggerated notions of its parent's power, and it will by-and-by cry for the moon. Let a people believe in government-omnipotence, and they will be pretty certain to get up revolutions to achieve impossibilities. Between their exorbitant ideas of what the state ought to do for them on the one side, and its miserable performances on the other, there will surely be generated feelings extremely inimical to social order—feelings which, by adding to the dissatisfaction otherwise produced, may occasion outbreaks that would not else have occurred." (*Social Statics*, p. 318.)

What, then, is the use of the Building Law? Beginning with a general laying down of a few important points, and backed in these points by public opinion, it has grown to be a large mass of minute rules with which public opinion has no acquaintance and no sympathy. From a handful of persons charged with enforcing the law the bureau has grown now to a hundred. Still the cry is for more laws, more and more minute and exacting regulations, more extravagant spending of other people's money in costly construction. With each intensification of the law the demand is for more inspectors to carry it out, or at least to collect pay for carrying it out. The law has become a political engine. Its offices are valuable considerations. The power which the law created reacts to perpetuate and increase the law, for with every increase of the law comes an increase of power to the political party that has the administration of it. The use of the Building Law is to help the politicians.

THE VENTILATION OF HOMES AND SCHOOLS.

I.

By Leicester Allen, A. B., M. E.

THE Gospel has been preached now nearly nineteen hundred years and yet it is said there are many sinners. If preaching is in any notable degree a prophylactic for sin evidently preaching ought to continue. Also many essays and books have been printed and numberless lectures delivered on the subject of ventilation; yet, it is safe to say, the most elementary knowledge of what good ventilation means and how to get it is chiefly confined to experts. The large majority of even intelligent people think that if a certain amount of exterior air flows into a building and an equal amount flows out, that operation is ventilation, and that good ventilation depends only upon the quantity of air so flowing.

In the April number of this magazine, in an article entitled "Heating and Ventilating Homes," I endeavored to show those who are inexpert that they should avail themselves of expert knowledge and skill. I tried to point out certain very common errors on the part of owners by which they often defeat their own wishes. Obviously, within the limits of that article the subject of ventilation, so intimately connected with heating, yet, in the principles involved separate and distinct, could scarcely be more than glanced at. In the present article, I must of necessity restate much that has been already said in different form by others.

And here, at the beginning, let me say I am not endeavoring to instruct professional experts. I shall wholly fail of my object if intelligent people, who have never given special attention to the science or art of ventilation, cannot easily understand what I write. I am given to understand by the editorial management of this magazine, that its aim and spirit is to present to intelligent readers, not technically trained, the "very age and body of the time";—this marvellous time, in which each day adds something to scientific achievement and mechanical resources;—in which scientific engineering and mechanical knowledge and skill are performing such miracles that not to know something about them is to be practically out of the world of thought and of action.

What I shall say follows more naturally the very able, interesting and instructive article by Mr. Walter B. Snow, in the July number of this magazine, than my own in the April number. His article indicates the increasing interest of the public upon all sanitary questions whether relating to refined homes or humble workshops. It is more and more recognized that the safety of individuals can only be secured by attention to the sanitary condition of all classes. More and more it is perceived that in the "wondrous vital air" may lurk unseen, subtle, deadly influences, and that too often domestic habits, criminal crowding of pupils in the poisonous air of close schoolrooms, and the confinement of operatives in the fœtid air of ill ventilated workshops are responsible for their presence. More and more it is discerned, that vigorous thought, placid temper, clear understanding and robust health are continuously possible only in an atmosphere such as nature intended mankind to breathe; whether it be in school, office, court-room, church, opera-house, or that beautiful outgrowth of advanced civilization the refined home of the nineteenth century.

To ventilate is, says Webster, "to open and expose to the free passage of air or wind; as, to ventilate a room; to ventilate a cellar." "To cause the air to pass through; as, to ventilate a mine." These definitions correspond with the popular notion, as any one may prove by conversation with people of average education and information. To the expert they are miserably inadequate. I hope that I shall be able to exhibit their inadequacy plainly enough to those who read my article in which, although in the limits permitted, it is hopeless to attempt an exhaustive discussion. I mean as much as I can to state clearly fundamental principles.

The average man asked as to the purpose of ventilation, will say it is to remove the foul air. Asked further as to what is meant by foul air he will, in nine cases out of ten, say, "why, it is air that has been breathed too many times." Asked what makes air too often breathed foul, most people will say, "I do not know exactly; I only know it is bad." Those somewhat better informed will mostly say, "*carbonic acid.*"

People in general regard carbonic acid as a poison. Do not people who go down in wells sometimes lose their lives from the presence there of carbonic acid? Is not a common method of suicide that of shutting one's self in a room with a pan of ignited charcoal? Do we not frequently hear of people found dead from

shutting themselves in rooms and "blowing out" instead of "turning off" the gas which "lighted fools the way to dusty death."?*

Here, then, is a popular error, still persistent, though often exploded. Carbonic acid is not poison. It is true that one can be, so to speak, *drowned* in carbonic acid, if he is surrounded by such a quantity as to prevent access of sufficient air to support respiration. The action of this gas in destroying life is the same as that of water when one is submerged;—purely mechanical; as much so as when a pillow is pressed tightly down over the mouth and nostrils. Under such circumstances people die because they cannot breathe. Yet paradoxical as it may appear, it is no less true, that so dying, they are poisoned to death.

People who are smothered, drowned or strangled, die of the poison generated in their own bodies, which, as soon as respiration is impeded or stopped, immediately begins to accumulate. Unless breathing can be restored this poison soon reaches a perilous quantity. This wondrous mechanism of ours inhabited by thought and soul, and through which "a thousand vital currents run" is, nevertheless, no matter how beautiful or attractive its exterior, a generator of poisonous emanations altogether distinct from carbonic acid, harmless when present in normal quantity, but destructive to health and even life when they accumulate. And if they accumulate in an inclosed space in which we are confined, they must also accumulate within us, because we are continually forced to reinspire them. The end and purpose of ventilation is, therefore, to remove from inclosed spaces these emanations together with any other real poisons which may have become added to them either from leaks in gas-pipes or fixtures, from soil-pipes, from defects in water-closets or any other source.

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* Cited because most people think that death caused by illuminating gas is the same as smothering or similar to death produced by carbonic acid gas in wells. Instead, it is a process of real poisoning. Illuminating gas is in itself a poison. Its inhalation, even in small quantity, produces immediate deleterious effects. It is not so with carbonic acid. Every time we drink a glass of so-called "soda water" we inhale a quantity of this gas; and the purest natural atmosphere contains from 2 to 4 parts of it in 10,000. So we are breathing it continually. It could not be otherwise with myriad stoves, furnaces and factory chimneys, vomiting carbonic acid into the open air and with the whole mass of animal and vegetable life constantly exhaling it. In the case of the charcoal pan also, it is not often the carbonic acid generated that is the immediate cause of death, but the simultaneously generated, deadly carbonic-oxide,—a real poison which, entering the lungs, acts directly upon the hemoglobin of the blood.

What then is the meaning of the tests which we see experts making to ascertain whether ventilation is good or bad? Some of us have seen them taking separate measured quantities of air from the top, the bottom, the sides, the middle of an occupied room, as a school, a church, a theatre, and passing these quantities separately and carefully through either slaked lime or baryta water. We have seen this water, at first limpid as crystal, turn in appearance to milk, and, after standing, get clear again by precipitating a fine white powder to the bottom of the vessel in which the experiment was performed. We have heard the experts say this powder is a carbonate of baryta, and that if the apparatus and its contents have been previously weighed, the increase of weight during the passage of the air shows exactly the amount of carbonic acid contained in the sample tested; and that if this be large, the ventilation in that part of the house is bad; the reverse also being true. If little carbonic acid be present the ventilation is good.

You will see that this method of testing is entirely independent of the volume of inflowing or outflowing air, and it is precisely on this account that it is valuable; for as we proceed we shall more and more perceive that we must not rely upon Webster's definitions if we wish to gain correct notions of good and bad ventilation. But how comes it that they seek to measure the carbonic acid which is not the poison to be dreaded, and indeed is not a poison at all, and which is, except in very rare cases, present in occupied buildings in so limited a quantity that by and of itself, it would be harmless?

I will make this clear by a simple illustration. Knowing the weight of water contained in each of a large number of tanks of equal capacity, to obtain the gross weight we would count the tanks and multiply the weight in each by the number of tanks. We would not under such conditions, even think of the direct method of weighing the water. Precisely as we might know the quantity of water contained in each of the hypothetical tanks, we do know that, in inclosed spaces occupied by human beings, and in which the air is known not to be vitiated by other causes than respiration and emanations from the skin, a certain amount of the really deleterious matter which it is well-nigh impossible to collect from the air and measure directly, accompanies the carbonic acid exhaled, and that the one bears so nearly a fixed relation to the other, that by determining the amount of the easily collected and retained carbonic acid we may at once infer from the quantity so

collected whether the noxious matters are present in objectionable quantity or not.

The experiment is not so simple that any one may perform it with sufficient accuracy, and with improvised apparatus, and thus determine for himself whether his house, his school, his office, is properly ventilated or not. For practical purposes, thirteen cubic feet of air may be taken as weighing one pound at ordinary temperatures. It is easy to contrive means for taking a definite quantity of air from any part of the room. An ordinary fire bellows after working it sufficiently to expel its contained air may be used. A rubber tube may be attached to its nozzle, by which air drawn in may be driven out under the edge of a vessel inverted in water, till sufficient air has been secured. But the water used for this purpose should have stood in the room to be tested long enough to absorb all the carbonic acid it is capable of taking up at the temperature of the room. The weighing, as the increase of weight will be small in quantity, will require a good balance ; but very good results can be obtained by balances such as are used in drug stores, almost universally accessible. There are, however, refinements necessary to be observed, which require a well-constructed apparatus and experience in its use, so that this method cannot be popularly applied.*

We have seen that the purest natural air contains from 2 to 4 parts in 10,000 of carbonic acid. When by the presence of people in an inclosed space the percentage rises from 6 to 7 parts in 10,000, the ventilation is bad. When the proportion is less than this, the ventilation is good. When the percentage of carbonic acid present is reduced to from 2 to 4 parts in 10,000, the ventilation is perfect, that is to say the air is as pure as it is possible to make it by ventilation. It is *possible* to keep the air breathed at this degree of purity, but generally impracticable on account of the cost of heating a sufficient volume of air to effect it.

But there are still other conditions of good ventilation. Not only must the average amount of impurity be sufficiently low, it must be uniformly low. It is a fact that in large rooms the ventilation may be good in one part and bad in another. Moreover the removal of the foul air must be done by substituting for it *pure* outside air, not, as is sometimes the case, air containing other impuri-

* For a full illustrated description of the apparatus with directions for its use, and different methods see "A System of Instruction in Quantitative Analysis," by Dr. C. Remegius Fresenius, New York : John Wiley & Son, 1870, p. 553, *et seq.*

ties, as dust from streets, smoke from chimneys, or worse gases from sinks and sewers. Yet more, the foul air must be replaced by air moving so slowly as not to create hurtful or annoying drafts anywhere; and as air and all gases have adhesiveness not only for other gases, but for solids and liquids, the disentanglement of such gases as it is desired to expel, is sometimes well-nigh incompatible with other essential conditions. In some cases the problem of properly ventilating some particular building, with such means as limits of cost will allow, becomes impossible of solution. The one way out of the difficulty, is what is known as *forced ventilation*, the application of which to factory buildings, was so well described by Mr. Snow in the article to which I have already referred.

And here I have arrived at the topic of means and methods; but I have found the subject too big to be handled in the space placed at my disposal for a single article.

I have often heard it said that all this writing and talking about ventilation is nonsense; that the simple principle that hot air rises and cold air falls comprises the whole gist of the subject. I once wrote some such rot myself in sophomoric years when I had read little, and knew less. The question of ventilation, as all will agree who have had any experience worth considering, either in attempting to effect it, or inspecting and observing the attempts of others. is an extremely complicated and difficult one. It is true that hot air rises and cold air falls, when nothing interferes with its natural action, but the freaks wrought by unsuspected causes in chimneys and flues, the deflections, the failures of air to move as anticipated either in quantity or direction,—are they not written in ineffaceable characters upon the memory of all engineers who have made a speciality of heating and ventilation? Are they not written in dollars and cents in their ledgers?

I need carry my memory back through less than four years to recall a ventilating apparatus costing over 7000 dollars, placed in a large and expensive church, erected under the supervision of an able architect by one of the most skillful contracting houses in the country, which any one (myself included) would, on mere inspection, have pronounced perfect. So pleased was I with the entire arrangement, that, at the first opportunity (the occasion of the dedication of the church), I attended with the sole view of ascertaining whether the ventilation would meet my anticipations. A worse ventilated building I never saw. The faults were soon discovered and remedied; but such are some of the uncertainties of ventilation.

Could forced ventilation be universally adopted the difficulties would not be so grave ; but, in general, for homes and our smaller schools, this method costs too much, and requires a mechanical supervision which in most cases it is impracticable to supply.

The engineer is in the majority of cases compelled to rely upon the establishment of currents into and out of buildings through differences in the specific gravity of air created by heat. Now these differences are and must be small, and, as a consequence, their force is and must be feeble. The currents are therefore easily obstructed and often actually reversed, the air flowing out where it should flow in, or perhaps moving only in limited and local currents within the inclosed space that should be but is not ventilated.

So often is this the case that the term "schoolroom smell" as indicating the sense to which it most readily appeals to an outsider entering an ill-ventilated school, has come to be a common test for determining the existence therein of an extremely deleterious quantity of poisonous animal exhalations and emanations. The carbonic acid will be found in such a school to rise to 6 parts and over in 10,000 parts of air. But it is not carbonic acid that is smelt, or which causes the pale cheeks, the languid dull appearance, the headache, of the occupants. The normal excretions together with foul gases of indigestion, of enfeebled, perhaps diseased lungs, of clogged skins, are doing the mischief. The teacher, too, has felt it and has possibly made attempts to better the quality of the air by opening doors or windows ; but sneezing and snuffing soon admonish him, that to avoid one peril he has invoked the aid of another. So the windows are again closed and the slaughter of the innocents proceeds.

The foul air resists expulsion ; it adheres to surfaces, to clothing saturated with it ; it lurks in corners and recesses. I will give a simple illustration of the way air sticks to surfaces. A simple experiment to demonstrate it is available to a smoker. Puff the smoke out gently over and in contact with the upper surface of a table or a marble slab in a still room, and mark how reluctantly it separates from such a surface. "Hot air rises, you say." Well, your breath charged with smoke may be many degrees warmer than the surface upon which you breathe, but it clings there nevertheless.

The peculiarities of diffusibility also merit attention. It is because of these that it yet remains a matter of dispute whether upward or downward ventilation is the best ; and the exact rate at which the deleterious gases exhaled diffuse into surrounding cooler

air has, in my opinion, never yet been experimentally and accurately determined. The means for good ventilation must be adapted to the end sought, to the conditions of particular cases, and if these are not, in the beginning, clearly perceived and stated, the means are likely to be inadequate to the end.

ADVANTAGES OF THE ELECTRIC STREET RAILWAY.

By H. B. Prindle, B. S.

IN this day of advancement it seems only reasonable to suppose that the already extensive and rapidly increasing use of electricity for street car propulsion is due to the fact, that it possesses in a marked degree advantages over its competitors, steam, animal power and the cable. The belief is strengthened by the fact, that among the street railway companies that have adopted it are to be found some of the largest and, at the same time, the most conservative companies in the country. Even if there were no other recommendations, its employment by such companies is good evidence that electrical propulsion of street cars has reached a state of perfection sufficiently high to warrant its general introduction.

Nearly every one is familiar with the struggles through which the electric railway passed before it assumed a condition alike successful from a commercial and practical standpoint, and although it may never be said of any system or method that it is entirely beyond the experimental stage, the electric railway certainly is beyond this stage in the ordinary acceptation of the term. Its permanency is unquestionable, and whatever changes may take place in the next few years will, in all probability, be in the nature of improved apparatus, the result of time and experience, rather than changes in the underlying principles of electrical propulsion. Roads now operating by animal power are fast changing to electricity, while the new road that does not employ it is the exception and not the rule.

The competitors of electricity in this field are steam, horses and the cable. In considering the merits of these systems steam may be omitted, as the past has shown that its use for street cars is not likely. There are but few cities in which permission could be obtained to operate steam roads, and to use inside the city limits apparatus which brings to the already sufficient nuisance an additional amount of dirt, noise, smoke and escaping steam. Aside from these objections by municipal authorities, the economy of steam locomotives is far below that of the large stationary engines

used in cable and electric systems, and their great weight causes a rapid deterioration in the track. Their use must be confined to the present long distance passenger and freight roads on which, as yet, steam exclusively has found employment. Many prominent engineers unite in saying that while up to the present time steam has been unchallenged on our great trunk lines, the marked development in electric traction points to a time not so very distant when steam shall have found a strong competitor in the electric current.

Leaving steam out of the question, the three systems in common use to-day—the cable, the horse and the electric current,—the last named embodies all the advantages of the two first and lacks those features which render the use of the two former open to serious objection. In the question of the adoption of any system of car propulsion, the first considerations are cost, operating expenses, safety, reliability and durability. Granting for the sake of argument that the operating expenses of electric, horse and cable roads are the same, are there not many advantages offered by the first over the second and third systems which would commend its employment and which would render its adoption certain? So far as the reliability of the system is concerned there can be little question. The experience of existing roads, many of which have known no tie-up while others have only had such trouble of a trifling nature, is the best proof on this point. Experience has shown, too, that the durability of the apparatus has been all that could be expected of machines and appliances subjected to the wear and usage attendant upon this class of work. The more important parts of the machines are subjected to no wear and but little depreciation, and the parts wearing have to be renewed no oftener than like parts in stationary engines used for equally arduous work. The secular press has done its best to damage the system by exaggerated tales of the dangers due to electricity at high speeds. So far, in this country at least, there is no record of any person having met death by the current from an electric railway. Fear, then in this direction is groundless.

Among the many advantages of electricity over the horse and cable systems is increased speed. In the cable and horse systems there is a limit to speed, which cannot be exceeded in the latter and cannot be increased or diminished in the former without great wear upon the cable. In the crowded city streets and in the suburbs, same speed, approximately, must be maintained. With the electric system all this is changed, and cars can be run at almost any desired rate. In the heart of the city they can be operated at

three or four miles an hour, and, if necessary, at twelve or fifteen, as soon as the crowded streets are passed. What does this increased speed mean? It is equivalent to rapid transit to and from the suburbs for the travelling public, and an increased car mileage and increased receipts. At the same time, the ability of a motor car to haul one or two tow cars should not be lost sight of, as this renders it possible to double or treble the carrying capacity of a road. Compare the cost and operating expenses of these extra cars with the cost and maintenance of enough horses to do the same work in what, it must be admitted, is a far less satisfactory manner, and the difference will be startling, to say the least. Some may contend that high speeds are not suitable to city and suburban streets, but the public may be relied upon to take extra precaution in proportion to the increased speed.

The reliability of the electric system commends it. Unlike the cable system, depending upon the cable for the management of its cars (since a break in the cable means stopping every car on the system and causing a long delay while repairs are being made) every car is an independent locomotive, capable of pushing a car which has become disabled; or a car may be removed from the track, so that the operation of the others may not be interfered with, in case of serious disablement. On many roads a system of feeders is arranged so that the accidental breaking of the trolley wire cuts out but one section, and cars on either side can operate without difficulty. A more flexible system than the electric is not to be found. It can be extended to cover more territory at less expense than any other; switching and turnouts are easily accomplished, and can be used where revenue derived from cars operated by other systems would not pay expenses. Experience has shown that where electric railways have been installed in districts sparsely settled they have carried great activity in building of new homes for those whose income precludes their living within city limits.

These are, briefly stated, some of the advantages which are brought by the use of electricity as a means of street car propulsion, but the most important features are to be found in the cost of installation and expense of operation. Those who are familiar with cable systems, with their enormous power plants and expensive conduits, can see at once how disadvantageous the comparison with the electric system will be. From reliable figures on first cost of equipment the average cost of five roads operated by cable in various parts of the country is $1,317,570.83, these roads averag-

ing in length 7.15 miles, making the cost of installation per mile of road about $350,000. Five roads operated by horse power cost on the average $759,609.25, or $41,283 per mile. Five roads using electricity as a motive power cost on the average $242,628, or $36,000 per mile. These figures show in favor of electrical equipments per mile of track of $5283 less than horse roads, and $314,000 less than cable. Assuming 10% for depreciation, the contrast between the three systems is not less marked. So much for original equipment, all of which is most favorable to the electric railway. A comparison of the cost of operation is more than likely to be incorrect, unless it is assured that the same expenses are included in each item which goes to make up the total cost of operation, and as comparison is the only method for attaining an idea of the comparative merits of systems so far as operating expenses are concerned, care should be taken that all comparisons are made upon an identical basis. From the report of the railroad commissioners of the State of New York for the year 1889, it appears that in the case of horse railways the average proportion of receipts to operating expenses for thirty-three roads was 79.39, while for electric roads two in number it was 53.50. From a similar report for the State of Massachusetts for 1889 the average proportion of receipts to operating expenses for thirty roads was 82.87, while for two electric roads it was 55.50.

From various reliable sources the following information is compiled regarding the operation of various electric railways:

Road No. 1.		Road No. 2.	
Length including siding	6.36 miles.	Length inc. sidings	6.232
Cars, 4 box, 3 open, total	7	4 box, 1 open, total	5
Total mileage for year	92,400	Total mileage of year	117,450
Total passengers "	465,713	" passengers "	561,832
Total round trips "	7,702	" round trips "	9.787½
Rate of fare, 5 cents.		Fare—Cash, 6 cents; tickets, 5 cents.	
Total income for year	$23,215.62	Total income for year	$30,906.62
" expenses "	12,966.91	" expenses "	19,479.33
Ratio of exp to inc	56%	Ratio	63 %

Road No. 3 (from May 30 to Sept. 30, 1890).

Length inc. sidings	6.69	Rate of 5 cents.	
Cars, 4 box, 6 open	10	Total income for year	$17,014.10
Total mileage for year	64,109	" expenses "	10,646.09
" passengers "	344,756	Ratio	62½ %
" round trips "	10,123		

Road No. 4.

Length inc. sidings.....	4.5
Cars, 3 box, 1 open	4
Total mileage for year.....	72,496
" passengers "	348,646
" round trips "	8,529
Rate of fare, 5 cents.	
Total income for year.....	$17,299.55
" expenses "	13,629.76
Ratio.....	79 %

Road No. 5 (operating by horses).

5 cars for 4 months, 1888:	
Earnings 4 mos.....	$5,021.89
Expenses.....	3,660.00
Ratio	73 %
(Operating by electricity.)	
5 cars corresponding 4 mos. 1889:	
Earnings	$7,810.13
Expenses.....	3,582.50
Ratio.....	46 %

Road No. 6 (operating by horses).

4 cars daily average.	
Receipts 12 mos. 1889.....	$19,472.55
Expenses.	18,558.08
Ratio	95 %
(Operating by electricity.)	
3.50 cars daily average.	
Receipts 12 mos	$29,136.78
Expenses	21,223.48
Ratio.....	73 %

Increase in yearly receipts with less cars in operation $9,564.23.

Road No. 7 (operating by horses.)

8 cars.	
Receipts 2 mos. 1889.....	$4,551.30
Expenses.....	2,872.95
Ratio	63 %
(Operating by electricity.)	
Receipts two corresponding mos. 1890.....	$6,488.42
Expenses,.....	3,584.40
Ratio expenses to recepts	55 %

Showing a gain in net receipts of $1,225.67 when electricity was used.

These roads are by no means special instances. The West End Street Railway Co., of Boston, is undoubtedly the largest electric railway system in the world, and the following data concerning its operations is of the greatest value. It must be borne in mind, too, that this Company has its power plants as yet incomplete and is now buying current to operate certain lines, and also that this showing is in the face of the disadvantage of changing from horse to electricity. When the power stations are completed and in running order it is fully expected to operate electric cars at an expense of not more than 20 cents per car mile.

The company is operating about 75 twenty-six foot cars which during the month of May earned forty-four cents per mile operated, and forty-six and nine tenths cents per mile operated during the first half of the month of June. When this long car service is extended the operating expenses will scarcely exceed 50%. The net earnings of the company gained over the previous year $15,000 in May. Such is the result of electrical propulsion in the largest system in the world, and further comment is unnecessary.

APRIL STATEMENT.

	Total.	Electric.	Horse.
Gross Receipts	$ 478,717	$134,321	$ 344,396
General Expenses	30,707	8,193	22,514
Track and car expenses	184,141	47,447	136,693
Motive power	147,933	30,194	117,740
Total operating expenses	362,781	85,834	276,947
Net earnings	115,935	48,487	67,449
Miles run	1,478,346	394,459	1,083,887
Ratio of mileage	100	26.68	73.32
Per cent. of operating expenses	76.82	63.36	80.62
Earnings per mile run	32.39	34.05	31.77
Expenses per mile run:			
Motive power	10.01	07.65	10.86
Car repairs	01.05	01.39	00.93
Damages	00.77	00.75	00.78
Conductors and drivers	08.03	07.33	08.28
Other expenses	04.68	04.63	04.70
Total expenses per mile run	24.54	21.75	25.55
Net earnings per mile run	07.85	12.30	06.22

MAY STATEMENT.

	Total.	Electric.	Horse.
Gross receipts	$ 519,244	$ 144,638	$ 374,605
General expenses	30,478	7,796	22,682
Track and car expenses	173,344	45,443	127,902
Motive power	149,896	30,924	118,972
Total operating expenses	353,720	84,163	269,556
Net earnings	165,524	60,475	105,049
Miles run	1,471,004	376,321	1,094,683
Ratio mileage	100	25.58	74.42
Per cent. of operating expenses	68.12	58.18	71.95
Earnings per mile run	35.29	38.43	34.22
Expenses. per mile run:			
Motive power	10.19	08.22	10.86
Car repairs	00.79	01.33	00.60
Damages	00.50	00.89	00.37
Conductors and drivers	08.01	07.36	08.24
Other expenses	04.55	04.56	04.55
Total expenses per mile run	24.04	22.36	24.62
Net earned per mile run	11.25	16.07	09.60

Of all systems of street railways, that which give the quickest transit is the one demanded by the travelling public, and that which gives the best results is the one desired by the railway companies. Electric propulsion satisfies both requirements.

UNDERGROUND VERSUS OVERHEAD WIRES.

By Herbert Laws Webb.

THERE is no question connected with electrical engineering which has been discussed more acrimoniously by electrical engineers themselves, and in which the general public has taken a greater interest, than that which concerns the removal of overhead wires in cities and their burial underground. It appears to be the belief of many that the question is a new one, but it is as old as the commercial application of electricity itself, in fact older. Those who experimented with telegraph systems early in the present century used underground wires. In 1808 Professor Soemmering, a Russian scientist, exploded mines electrically through an underground wire a mile long. Sir Francis Ronalds, a few years later, had a complete telegraph system laid out in his garden at Hammersmith, near London, and his buried wires were insulated with glass tubes. The first practical telegraph system in the world, that of Cooke and Wheatstone, was operated in 1837 by means of underground wires.

The art of insulation, however, was at that time in its infancy, and underground wires yielded to the better working overhead lines. Electrical engineers in Europe have nevertheless always been in favor of placing their wires underground whenever practicable, and as improvements in manufacture were brought about and experience was gained in the treatment and behavior of insulated wires, underground work gradually came to the fore. In London, for instance, the telegraph wires are entirely underground, except where pole-lines can be carried along the railway routes or canal banks ; and this great system, which to-day contains many thousands of miles of wire, was begun early in the forties. In other great cities in England the telegraph wires are all underground, but in the open country they run overhead. The engineers of the Post Office have always strenuously opposed the absurd demand which is occasionally raised for the wires to be placed underground everywhere ; as they know that to comply with such a demand would cause an enormous expense and reduce the working capacity of the wires. To all sensible people it should be quite evident that if electrical engineers put their wires underground in the

centres of population they have done all that can fairly be demanded of them.

To the majority of those who in municipal halls, newspapers, and other places where they can make themselves heard, cry out "bury the wires," "the wires" are just wires and nothing more. They recognize no other difference between a telephone wire and one used for electric lighting on the high tension alternating current system, than that the one is harmless (unless it is crossed) and the other is dangerous. Both wires need insulation and both need burial, and so do their sisters and their cousins and their aunts—the wires of the telegraph, messenger, electric power and low tension electric light companies. Therefore the cry is, cut them down and bury them forthwith.

But to the electrical engineer the question of burying his wires assumes quite a different aspect according to the purposes for which the wire is to be used. If he is a telegraph engineer he knows that a wire covered with an insulating material and buried underground will lessen the speed of transmission, because the current travels more slowly than in an overhead wire, owing to the increased electrostatic capacity. This quality of electrostatic capacity—which is a sort of absorption of the current by the insulating material—is always present; it varies greatly with different kinds of insulation; it is least in bare overhead wires, and greatest in underground or submarine wires insulated with gutta percha or rubber compounds. To the telephone engineer, electrostatic capacity is vastly more offensive than to him of the telegraph, because of its deadening effect on underground wires. In telephone cables, too, the wires are brought very close together, and facilities for induction from wire to wire are greatly increased. These difficulties combine to render the insulating materials suitable for telegraph cables altogether impossible for telephone work.

When we come to the electric transmission of power and electric lighting, we find further material differences. The question of insulation reigns supreme, although those who have to do with alternate current distribution are beginning to find out that electrostatic capacity, which a short time ago they did not take into account at all, has a distinct bearing on the behavior of their cables under certain conditions. Insulation for low tension currents means something quite different from insulation for high tension currents. Under the continuous current system of distribution of current for light and power, the tension is always low, and therefore, its tend-

ency to break down the insulation is limited, and the insulating materials need not have a very high resistance. The Edison tubes, which are such familiar objects in the streets, contain bitumen, an insulator of a comparatively low order. But when the tension amounts to several thousand volts instead of a hundred, something quite different must be used. The insulating material is subjected to a continual stress tending to search out any weak point, and break it down by the sparking through of the current. Therefore, for conductors carrying these high tension currents insulating materials having high resistance and homogeneousness must be used.

Such electrical problems as the above indicate that the question of burying the wires is by no means a simple one.

Of course the first cost of establishing underground systems of communication and distribution is considerable, and as money always talks, money found at first innumerable arguments with which to oppose and condemn the introduction of such methods. Those times are past now, or they are quickly passing away, and electrical engineers the world over are pledged to underground work in large towns and cities.

Much of the bitter feeling which has characterized the discussion of the underground question, has undoubtedly been due to the manner in which ignorant municipal bodies have constituted themselves authorities on engineering and scientific matters, and to the sensational treatment of the whole subject by the daily press, which has spread abroad picturesque misinformation. The people, moreover, should have been represented in the matter by the best engineering talent available, so that the work might have been done expeditiously, but thoroughly and efficiently. Instead of doing that they have in many instances left the work to statesmen of immature citizenship, and political heelers, whose sole aim in life is power and plunder.

Notwithstanding these difficulties, electrical engineers are doing what was demanded of them with entire credit to themselves ; and in many cities of the United States, underground electrical work has made very satisfactory progress. What was a few years ago an innovation of a startling character is accepted now as an everyday feature of electrical engineering, and has been rescued from a chaos of competing methods and systems.

Returning to the practical side of the question, we come to the subways proper. Of subways and conduits there is an infinity of different systems, many of which are but little used, owing to de-

fects quickly revealed in actual practice. The requirements are comparatively few and simple. The ducts should be strong so as to preserve their alignment even if subjected to very heavy stresses from above; they should be of such size as to permit the cables to be readily drawn in and out; there should be large, well ventilated and moisture proof manholes at frequent intervals to facilitate the work of drawing cables in and out, making joints, and carrying off subsidiary ducts for leading cables up to distributing points or into buildings. In subways the system which most nearly approaches to the accessibility of overhead lines is by all odds the best, and those in which the wires are inaccessible except at long intervals, or in which the wires, when once in, have to stay in, can only have a very limited application.

The subways in New York consist for the most part of tiers of wrought iron pipe held in position by layers of hydraulic cement concrete, manholes being built at intervals of a few hundred feet. This system, properly constructed, works exceedingly well; nothing simpler can be desired, and every class of cable, from that which carries the delicate undulations of the telephone to that charged by the fervid throbbings and pulsations of the high tension alternating current dynamo, can be safely and satisfactorily accommodated. For many years the telegraph wires in London have been laid in iron pipes placed underneath the sidewalk, handholes being placed at short intervals to permit of the placing of new wires and inspection and repair of old ones. The iron pipes that have done such good service in London have been found thoroughly satisfactory in New York, where, of course, the work has been done on a larger scale, as the subways have been built to accommodate all classes of cables.

The cables that are used in the subways in New York are of a number of different types as regards the methods of insulation, but there is unanimity of opinion as to the advisability of protecting the insulating covering by means of an external armoring of lead. All of the insulating materials that can be used for covering cables are more or less perishable if exposed to moisture, gases and alternations of temperature, and all, of course, are extremely susceptible to mechanical injury. Securely enveloped in a lead coating, which is put on under pressure, they are safe from injury from any of these causes with the exception of temperature. Heat lowers the resistance of all insulating substances, and the subways in the lower part of the city are kept extremely hot by the mains of the

steam company. In some places the ducts are so hot that it is impossible to hold one's hand to a cable immediately after drawing it out; in many of the manholes a temperature of 170 or 180 degrees Fahrenheit is by no means uncommon.

With the system of subways and the class of cables just described, it is easy to see that the task is not so difficult, nor is it surrounded by the complications that many people believe it to be. The cables are taken on reels to the manholes and pulled through their respective ducts by means of a rope attached to a windlass at the next manhole. The joints and splices are made in the manholes by experienced workmen, and, although trouble is sometimes experienced with joints, a careful man will make a joint having just as good an insulation as an equal length of new cable. Of course the laying of a cable under ground in this manner is not quite such an expeditious piece of work as the stringing of an unarmored wire on poles would be, but there are no greater practical difficulties; and it must be borne in mind that several electric light cables can be drawn into the same duct at the same time, while the telephone cables contain one hundred conductors each. Following up the contrast, if we take the poles and cross-arms of an overhead line as being equivalent to the subways, the time and labor expended on placing the wires in position are pretty nearly the same; in the case of telephone wires the subway has decidedly the best of it, as a hundred wires are put in position simultaneously.

The disadvantages in working of underground wires as compared with overhead, leaving aside entirely the unfavorable electrical conditions in the case of telegraph and telephone lines previously alluded to—may be summed up very briefly. One is the necessity of having so many joints in the wires, as a joint may, if not very carefully made, develop into a weak spot. This difficulty, which was a serious one at first, has however been removed to a great extent by experience and its resultant skill and care. The chief disadvantage is that any defect in the insulation at any point results in the immediate breaking down of the cable; the lead armoring practically forms a perfect ground, and if there is any weak spot in the insulation it will rapidly develop under the action of the current until the cable is completely "grounded," and therefore useless for further service until repairs are made. In an overhead wire the insulation might be defective in several places between the points of suspension, but no great trouble would be experienced as long as the wire was clear from contact

with all others, and properly insulated at the points of suspension. An underground wire must be thoroughly insulated along its entire length.

Many of the difficulties that occurred in the early days of underground work were due to experiments with untried methods of insulation, and to inexperience in the important matter of making joints; but the manufacturers have made great strides in the last few years. The greatest difficulties of all have naturally fallen to the lot of the companies who distribute current at high tension, because the higher the pressure of the current the greater the stress on the insulation. To put it in technical language, the stress on the insulation increases as the square of the voltage. Thus a current of 1000 volts would strain the insulation, not ten times as much than a current of 100 volts, but 10,000 times as much. So it is evident that the insulation of conductors carrying high tension currents must be of the most perfect description that can possibly be secured. As an instance of the progress that has been made in the manufacture of electric light cables, it may be mentioned that cables have been made in New York the insulation of which has not broken down under a pressure of over 11,000 volts. Whenever the insulation of an underground cable does become defective, it is a comparatively easy matter to locate the defect by means of electrical tests, and then to withdraw the faulty section and splice on a length of sound cable. Even if a cable should fail suddenly, the necessary repairs can be made almost as quickly as on an overhead line, while daily tests give timely warning.

That underground wires, even for high-pressure currents, give satisfactory service is now beyond all question, and ample evidence of this fact is available in several quarters. In New York one electric light company alone is operating about two hundred miles of underground cable chiefly for high tension distribution, and not long ago the superintendent of that company assured me that so well systematized had the work become, and so good was the quality of the cable now supplied, that for a long time past the only serious trouble they had had was due to the work of some ingenious miscreant, who had driven a nail into one of the cables in such a manner as to defy detection except under the closest scrutiny. In Chicago the Arc Light and Power Company had at the beginning of this year upward of 150 miles of "high tension" cable in operation, and during 1890 there were only 31 cases of "trouble" on these cables. Of these, 18 or nearly two-thirds were due to me-

chanical injury, 4 to defective joints and 2 to defective insulation, leaving 7 the cause of which was not accurately determined. Surely this is a good enough showing to convince any one that underground wires can be successfully operated even with "high-tension" currents.

The greatest sufferers by the burial of the wires are the telephone companies whose systems connect with the long distance lines. A short length of underground cable has little or no effect on telephonic transmission, but when a few miles of underground cable are joined on to several hundred miles of overhead line, the effect is very marked, the speech becoming muffled, thick and indistinct. All cities ought to make allowance for this apparently insuperable difficulty, and allow the wires of the long distance system to be carried overhead. For local telephone work, underground wires work admirably. The telephone system of New York from the Battery to the Harlem River is entirely underground, and there are to-day under the streets of New York considerably more than 20,000 miles of wire used for telephonic communication.

The great objection to underground electrical work is the heavy outlay demanded by the construction or rental of subways and the cost of insulated cables of a high grade. Its advantages are economy in maintenance and repairs, certainty of working, and freedom from the numerous accidental interruptions that overhead lines are subject to; and entire immunity from the general interruptions caused by storms of unusual violence. The type of underground cable now in general use should have a very long life. The lead covering is practically indestructible; if laid in iron pipes it cannot be affected even by galvanic action, because iron is electropositive to lead, and the iron would be attacked. As the insulating material is hermetically sealed within the lead covering, it is safe from deterioration as long as the lead remains sound. So that unless it is found that the insulating materials deteriorate by reason of the action of the current, the depreciation on underground cables of this class should be placed at a very low figure. In contrast, the depreciation of overhead lines is very considerable, especially in towns where the wires are exposed to the action of smoke and gases besides the influence of extremes of weather.

In large towns and cities the underground system is among the established order of things, while freedom must be conceded for overhead wires in the open country and on restricted routes.

THE Blasting Out of the Rocks in the Channel of the Danube, which have been known under the name of the "Iron Gates," is in active progress, the whole work being under contract by an engineering firm of Brunswick, which has undertaken to complete it in five years at a cost of less than $4,000,000. The contract has been made with the Hungarian Government. An official request for tenders failed to bring any offers from any quarter. Tolls will be levied upon the passage of vessels through "The Gates" until such time as the government is reimbursed for the original outlay.

The Frightful Railway Accident at Mönchenstein in Switzerland appears, from what can be inferred from the accounts which have reached us, to have resulted from the fatigue of the iron. However, experts have not yet pronounced as to whether the accident is due to the quality of the iron or to defects in the construction of the bridge. The wholesale destruction of life which occurred has rendered it exceedingly difficult to get details of the manner in which the accident occurred. Possibly the train jumped the track, but no one knows this. The bridge was erected sometime between 1870 and 1880, by M. Eiffel, of Paris, whose name has since become known throughout the world in connection with the famous tower at the Paris Exposition. It appears moreover that in 1880 a complaint was made with reference to the bridge and it was examined by government inspectors who pronounced it defective. It is further stated that examination has shown the iron originally used in the construction of the bridge inferior to that which was employed in its repair subsequent to the report of the Government inspectors. M. Eiffel states that he constructed the bridge in exact conformity with the plans of the Jura-Simplon Railway Company, the directors of which, however, deny this allegation, and throw the whole responsibility upon the contractor. M. Grepin, a French engineer, studied the condition of the bridges over the Birs prior to 1880, and published a report in the form of a pamphlet which contained strictures upon the construction. He maintained that the engineers were not sufficiently familiar with the topography and hydrography of the land; that they had underrated the water courses which, though called creeks, were often converted into formidable streams by rain storms and melting snow; and that several of the bridges were slight and flimsy structures. According to this pamphlet it also appears that as early as 1876 the bridge at Mönchenstein developed such weakness that there was hesitation in crossing it with trains. It is well known that iron structures which are overloaded frequently break down suddenly under strains no greater than those which they have often borne with impunity, the iron gradually becoming weaker from the overtaxing of its tensile strength.

Engineers as Arbitrators between their clients and their contractors was a part of the subject of an interesting paper entitled, "The Engineering Profession," presented by Major W. F. Foster, of Nashville, at a recent meeting of the Engineering Association of the South. He maintains that this is the true status of

engineers with relation to their clients and their contractors and that they are not agents of their clients. He maintains that as it would be disgraceful for an engineer to receive a bribe from a contractor as an inducement to accept inferior work, it would be equally dishonorable to allow his salary to become a bribe.

The New Whale-Back Steamers are exciting much interest in marine engineering circles. The shooting of the rapids in the St. Lawrence River by the whale-back *Colby* (variously stated as being 256 feet and 265 feet in length, 38 feet beam and 24 feet deep) which has been followed by the performance of the same feat by others of her class, has demonstrated possibilities with this kind of steamer not dreamed of until very recently. The owner of the *Colby* took, in the opinion of many experienced navigators, a great risk, as the underwriters would not insure the vessel, and if anything had happened during the passage to damage her he would have been obliged to have sustained the entire loss. It has been reported that this kind of vessel will be likely to supplant the oil tank steamers for the future transportation of oil. The latest launch of a vessel of this class was the *A. D. Thompson*, the thirteenth which has been built. She is provided with triple expansion engines, which have been designed and constructed in England, and is the duplicate of the *Charles W. Wetmore*, which recently sailed for the Atlantic from the head of Lake Superior and is to go to England with wheat. In order to go down the Rapids it was necessary not to load the *Wetmore* to her full capacity. She is, at present writing, expected to take on board 100,000 bushels of wheat on her arrival at Montreal, which will complete her cargo. The *Colby* and her tow will engage in the Atlantic Coast trade for the present. It is stated that she may subsequently go around Cape Horn to the Pacific.

Another Item of Interest relative to our lake marine is that the lake ship-builders have recently underbid the constructors on the Atlantic seaboard on the building of four steel light ships to go down the canals for service on the Atlantic. It is quite evident that our inland ship-yards must hereafter be considered as competitors by Eastern iron ship-builders. There were four bids from the seaboard and six from the lakes, the latter all being lower than the former. The contract was awarded to F. W. Wheeler & Co. of West Bay City. We append the bids of the lake builders:

Name and Address of each bidder.	For No. 51.	For No. 52.	For No. 53.	For No. 54.	For all 4 vessels.
Chas. Reeder & Son, Baltimore, Md	$.....	$.....	$65,450	$65,450	$ .....
Harrison Loring, Boston, Mass., provided bids for two are accepted less $2100 on each vessel as per telegram...	66,000	66,000	66,000	66,000	264,000
Samuel L. Moore & Sons, Company, Elizabeth, N. J.	63,500	64,415	65,065	65,065	255,445
Pusey & Jones Co., Wilmington, Del.....	.....	68,000	.....	.....	.....
David Bell, Buffalo, N. Y.....	45,500	.. ...	.....	.. ...	.....
Craig Ship Building Co., Toledo, Ohio...	52,738	50,338	50,838	50,838	199,920
Union Dry Dock Co., Buffalo, N. Y.....	60 000	65,000	67,000	67,000	259,000
Detroit Dry Dock Co., Detroit, Mich.....	.....	.... .	.....	.....	230,000
F. W. Wheeler & Co., West Bay City, Mich	47,900	48,000	48,100	48,100	189,300
Cleveland Ship Building Co., Cleveland, O.	61,000	61,000	61,000	61,000	240,000

Samuel L. Moore & Sons Company, of Elizabeth, N. J., proposed, in addition to their bid of $255,445 for all four vessels, to build Nos. 53 and 54 for $128,980. The bid of the Pusey & Jones Company, of Wilmington, Del., asked for seven months in which to build one of the boats, No. 52.

"A Move for Better Roads" is the title of a volume published by the University of Pennsylvania Press, the price of which is $2.00, and which is sold by Henry Carey Baird & Company, 810 Walnut Street, Philadelphia. It was prepared under the auspices of the University of Pennsylvania and comprises essays on road-making and maintenance and road laws for which prizes or honorable mention were awarded through the University of Pennsylvania by a committee of citizens of Philadelphia, with a synopsis of other contributors and

a review by the Secretary Lewis M. Haupt, C. E., Professor of Civil Engineering in the University of Pennsylvania, and, as our readers will immediately recall, a valued contributor to this magazine. The book also contains an introduction by Mr. William H. Rhawn, Chairman of the Committee. The work is handsomely published, well indexed, bound in cloth and forms a valuable contribution to the literature of road-making.

"The Topographer, his Instruments and Methods," is a well-printed, illustrated and valuable treatise by Prof. Lewis M. Haupt, designed for the use of students, amateur topographers, surveyors and engineers, and all persons interested in the location and construction of works based upon topography. The illustrations comprise numerous plates, maps and engravings. This book is published by Henry Carey Baird & Company, whose address is given above.

The Discussion of the Road Question brings to light some conflict of opinion. In a paper recently read by Mr. J. M. Heiskell before the Engineering Association of the South he maintained that economy of street and highway traffic could best be secured by paying attention to improving the vehicle rather than the road surface, and to accomplish this he recommended strongly the introduction by proper legislation of the following features in the construction of vehicles: 1. Width of tire to be dependent on weight of load. 2. Length of axle to be dependent on weight of load in order to insure non-tracking of vehicles. 3. A difference of length between front and rear axle to insure non-tracking between front and rear wheels. 4. The introduction of springs for heavy draft wagons. The paper presented estimates based on quotations from paving companies, giving their prices for guaranteeing the maintenance of their pavements for terms of years under existing circumstances and also under conditions to be secured by legislation requiring the above improvements in vehicles. Those familiar with the operation of the earlier turnpike roads in this country will remember that tolls were remitted to those who used vehicles having wheels of a certain breadth of tire, as the passage of these vehicles over the road was considered to improve, rather than injure the roadway. Mr. Heiskell's recommendation seems to be for a return to this old system.

Oil and Gas Engines are Stated by *Engineering*, London, to have been the chief features of interest in the recent Doncaster Show of the Royal Agricultural Society of England, and among the oil engines the one which has attracted the most attention is one called the "Oil-Gas Engine," deigned by Messrs. Crossley Brothers, Limited, of Openshaw, Manchester. According to the description given in the journal named, this engine is of 4 horse-power nominal, capable of indicating 9½ horse-power. Possibly some of the oil is converted in the vaporizer into a permanent oil-gas. But it is to the form and method of working of the engine itself that the appellation "gas" applies most directly. At a casual glance it is difficult to tell one type of engine from the other. In Messrs. Crossley's engine the oil is delivered by a pump directly into a cast-iron vaporizer, this pump being driven by a hit-and-miss motion, controlled by an inertia governor. The vaporizer is kept hot by a lamp of very simple construction. It comprises a shallow vessel in the centre of which is an air jet surrounded by an annular tube through which more air can be drawn by the action of the jet. Over the whole is a cover with a central opening. The lamp is supplied with oil from a small tank in which it is kept at a constant level by the device of pumping it in faster than it is wanted, and allowing it to flow back by a waste pipe. The air jet is fed from a pump operated by the same lever as the exhaust valve. This pump has a loose-fitting piston, and does not require lubrication. Its effect is sustained by means of an India-rubber diaphragm which, by retraction, maintains the blast while the pump is making its back stroke. To commence operations the oil in the lamp is fired, and then the pump is worked by foot. The rush of air carries up the petroleum vapor, making it burn with a blue flame of very considerable power. In ten minutes the vaporizer is hot enough for the engine to start, after which the working of the pump is automatic.

The lamp has neither wick nor fine passages, and every part is perfectly accessible for cleaning. The firing is effected by a horizontal hot tube with a snifting valve which keeps the tube clear by an intermittent air current, and a timing valve fixes the exact time at which the combustible mixture is fired.

Nine New Lake Steamers, including the whale-back *A. D. Thompson*, have, according to Lloyd's Inland Register, been added to our Lake Marine in July. Their aggregate carrying capacity is 9006 net tons, and their aggregate value is $1,238,000. The following is a list of these vessels:

Vessels.	Net tonnage.	Value.
Virginia.....	980	$300,000
Atlanta.....	958	135,000
Roman.....	1,875	200,000
E. B. Bartlett.....	1,075	145,000
O. O. Carpenter.....	268	25,000
John Duncan.....	997	90,000
Griffin.....	1,526	165,000
Ideal	13	5,000
A. D. Thompson.....	1,075	145,000
Totals.....	8,767	$1,210,000

Boiler Inspection and Insurance, as conducted in England, appear to be giving rise to some dissatisfaction. A correspondent of *Engineering* (London) states that not long ago a boiler exploded the very day it had been inspected and reported safe by an inspector in the employ of one of the principal companies. He adds that instances might be mentioned of companies that have more than once been turned over the coals for insuring boilers and not examining them as they ought to have done, allowing them to go from bad to worse until fatal and disgraceful accidents have resulted. A bill is now before the English Parliament to provide for securing a higher grade of competency on the part of inspectors. It has been intimated that boiler and inspection insurance companies may possibly find it to their interest not to be too critical in inspection, as the prevention of all accidents would tend to produce a feeling of security on the part of boiler users that might lead to indifference on the subject of insurance.

The Castlewood Dam, which is intended to impound waters in a reservoir covering 200 acres and of a capacity of 230,000,000 cubic feet, is in process of erection 25 miles above the city of Denver. A great deal of controversy has been going on with reference to the construction of this dam, some claiming that it is being so poorly constructed as to endanger the safety of the city, while others claim that it is built in all respects as a dam should be. It is stated that probably the controversy will get into the courts.

Another Addition to Engineering and Mechanical Resources are the "Mannesman" steel, seamless tubes. These tubes are capable of being made of extreme thinness, while at the same time they withstand enormous pressure. Some very interesting statements are made with reference to their use in the Kedeberg copper mines and foundries in the Lesser Caucasus, owned by Dr. W. Siemens. "Masut," a distilled form of raw petroleum, obtained in bulk at Baku, is used at these mines as a substitute for coal and wood, both of which are scarce in that locality. It is used in large round furnaces, into which it is forced under a system devised by Mr. F. Siemens, which involves the use of steam at high pressure in the form of spray. To get the "masut" to the works has been a very difficult problem as they are situated on a high plateau only reached by surmounting very precipitous ascents. The transport of the material was only possible by mechanical means. Due consideration was given to the use of mountain railways of the cable and rack varieties, but the difficulties in applying these systems appeared insurmountable, and the use of a tube through which the "masut" might be pumped up from the railway station at the foot of the mountain was the scheme adopted. But here it was found that a pressure of not less than 1500 pounds per square inch would be required, and no tubes yet constructed were known that would bear this pressure except the Mannesman seamless steel tubes. The distance from the railway station to the works is 28 miles, and the "masut" is now pumped up through 14½ miles of the tube. From the

termination of this tube the "masut" has now to be transported to the works over the plateau, but the success in the use of the tube has been so marked that it will be continued on to the works and thus obviate any necessity for other means of transportation. The tube is 100 millimeters in diameter and 4¼ millimeters in thickness. Completed tubes of this character in long sections have satisfactorily withstood a pressure of 2250 pounds per square inch. The tube is stated to be absolutely without leakage.

A New Diving Dress has been made the subject of an English patent by Col. W. Carey, C. B., late R. A., which is claimed to embody the following hitherto unused principles in the construction of diving dresses. It is pressure resisting and it is intended to protect every part of a man's body from the pressure upon and surrounding him. The leg and arm casings are flexible in all the joints, but the dress itself and all its parts are of such buoyancy that it will not only carry its own weight, but that of the diver. The invention is said to have been suggested by the study of the protecting coverings of the crustacea, which have perfect mobility in the water, and hence the name "Crustacean Dress" has been given to this new apparatus. Of course some method of anchoring or weighting will be necessary to enable a diver to do any efficient work below water. How far this point has been considered and provided for is not yet apparent.

The regular June Meeting of the Engineering Association of the South was held at the Y. M. C. A. building, Nashville, Tenn., on Thursday evening, the 11th of June. A paper was read by Mr. R. L. Johnson upon the experiments conducted by the Engineering Department at Vanderbilt University to determine the bursting strength of the different sizes of ordinary sewer pipe. A paper was also read by J. M. Heiskell, assistant engineer of the Memphis Bridge, Memphis, Tenn., upon the maintenance of good roads. An abstract of this paper will be found in another place in this department. Mr. Johnson's paper is noticed at greater length in the Department of Architecture. Another paper of interest was read by Mr. J. J. Ormsby, Superintendent of the Thomas mine of the T. C. I. & R. R. Company, Whitwell, Tenn., a notice of which will be found in the Department of Mining and Metallurgy.

The Western Society of Engineers has made arrangements for an annual summer meeting of the society to be held Wednesday, September 2, of the present year, in the city of Chicago. The Illinois Central Railroad Company, the president of which is a member of the society, has arranged for an excursion to the World's Fair site at Jackson Park, Pullman, and thence over the Chicago, Madison & Northern Railroad entrance into the city of Chicago. During the excursion the society will inspect the shallow steel floors for railway structures, interlocking systems, four track three panel skew bridge, balanced double track, interlocked draw-bridge and the Illinois Steel Works, all on the railroad over which the excursion will be made.

A Telegraphic Cable to Hawaii is to be laid, and the *Thetis* of the United States Navy has been commissioned to make the preliminary survey. The system of sounding originally devised by the hydrographer of the Navy Department will be used. This method consists in taking soundings at alternate intervals of 2 and 10 miles except when indications of shoals are found, when the sounding will be only at quarter-mile intervals. The cable will connect San Francisco with Honolulu.

Reports from the Survey of the Route of the Inter-Continental Railway in South America indicate that everything is going along well, and that the engineers are finding no serious difficulty in the progress of the work. The Government officials are everywhere taking great interest in the undertaking and are affording every facility to the engineers.

The Greatest Railway Mileage in any of the United States is that in Illinois, which has 10,163 miles of main line, 926 of second, third and fourth tracks, and 2928 miles of sidings.

The Strength of Malleable Iron Castings has been made the subject of investigation and discussion by the Master Car Builders' Association. This discussion has divulged the fact that the data for determining the strength of malleable cast-iron hitherto existing are extremely meagre, and tests have been made with a view to supplying better data. The table herewith given comprises results of tests made in the laboratory of the C. B. & Q. R. R. Upon

Nominal dimensions. Inches.	Actual dimensions. Inches.	Area in square inches.	Tensile strength per square inch.	Per cent. of elongation in 4 inches.	Elastic limit per square inch.
1/2 x 1/4	1.52 x 0.25	0.38	34,700	2	21,100
1 1/2 x 3/8	1.52 x 0.39	0.593	33,700	2	15,200
1 3/8 x 1/2	1.53 x 0.5	0.765	32,800	2	17,000
1 1/2 x 5/8	1 53 x 0.64	0.979	32,100	2	19,400
2 x 3/4	2 x 0.78	1.56	25,100	1 1/2	15,400
1 1/2 x 7/8	1.53 x 0.88	1.355	33,600	1 1/2	19,200
1 x 1	1.06 x 1.02	1.08	30,600	1	17,600
1 1/4 x 1 1/4	1.28 x 1.3	1.164	27,400	1	.....
1 1/2 x 1 1/2	1.52 x 1.54	2.341	28,200	1 1/2	.....

the results of these tests the *Railway Age* remarks that "while we have no reason whatever to suppose that malleable iron will average any better than the tests in the report indicate, we have a personal knowledge of cases in which tests made simply for the purpose of determining the ultimate strength of certain castings gave higher results than those given in the report and indicated that the elastic limit was also considerably greater. But these were not numerous, and only go to show that further information is desirable."

A Trial of a New Monster Triple-Expansion Pumping-Engine was made at the Omaha (Neb.) Water Works on the 29th of June. The engine is designed to pump 18,000,000 gallons a day against a head of 310 feet, when running at 20 revolutions per minute. This is sufficient to give professional readers an adequate idea of the proportions of the engine. For those not prepared to make inferences from so brief and simple a statement, it may be added that the diameters of the high pressure, intermediate and low pressure steam cylinders are, respectively, 40, 70 and 104 inches; that the stroke is 5 feet, that the total height of the machine above the foundation (including of course the pump cylinders) is 53 feet; that its weight is 1100 tons, and its cost $150,000. It was built by the Edward P. Allis Company, Milwaukee, Wis., from designs by Mr. Irving H. Reynolds, a young engineer of great promise, not yet past his thirtieth year. This gentleman was treated to a grand ovation by the citizens of Omaha upon the occasion of the public trial of the engine. He bore his honors with modesty, as would have been expected by those who have the honor to be personally acquainted with him, among whom is the writer of this paragraph. The water works at Omaha, now include not only the engine just erected, but also a "Holly" pumping engine capable of delivering 14,000,000 gallons of water daily; all of which, being taken from the muddy Missouri, requires purification before it is fit for general use. The magnitude of this part of the work of supplying water to the city will be comprehended by any one when it is added that, at present, from the 16,000,000 gallons required for daily use, 100,000 pounds of mud are extracted before the water passes into the city mains. The city has now a surplus capacity of 16,000,000 gallons, beyond its average daily requirements. Mr. Reynolds, when vociferously called upon to make a speech on the occasion referred to, immediately responded in the most eloquent address delivered by any of the speakers present. As it contained only eight words we may quote it entire, "The engine speaks for itself. I have nothing to add."

The Monster Plant of the Walker Manufacturing Company, at Cleveland, Ohio, has a machine shop 170 feet wide, and, when finished it will be 500 feet long. The foundry is 118 feet wide and 300 feet long. A 30-ton crane is located in each department of the shop. One of its lathes, finished by the Niles Tool Works, is 40 feet long. The entire plant is now working on cable railway machinery, mining machinery and travelling cranes, the two latter being specialities of these works. The *Marine Review* states that this company recently shipped a 66½-ton spur gear wheel 30½ feet in diameter to South Africa.

UTILIZATION of Exhaust Steam for Heating Large Buildings formed part of the subject of an able paper read by Mr. Charles E. Emery, before the American Society of Civil Engineers. As is well-known, Mr. Emery is a gentleman of large experience in this line of business as well as an able engineer in all respects, hence what he says on the subject is not only authoritative but instructive. With reference to the qualifications necessary to do steam heating in a proper manner, Mr. Emery said that "steam heating, considered simply as a business, has been practised with some measure of success by every steam fitter throughout the country, but such business is really founded on scientific principles worthy the efforts of engineers of talent who have had the best opportunities." This is shown by the results accomplished by the author of the paper and his associates, long before steam fitting as a business became established, and it will be seen that recent efforts are but modifications of the developments so thoroughly worked out years ago in the Eastern mills.

With regard to the heating of large buildings in cities by exhaust steam, Mr. Emery stated that only in few instances is the surplus of steam in any building distributed to adjoining buildings. He stated that a suggestion had been made to connect the exhaust pipes of the engines of various establishments to a common street main, and thus distribute the steam to other buildings for heating purposes. This idea was carried out in a steam plant at Lynn, but for financial reasons failure resulted. He stated also that the plan had been worked out in detail by collecting the exhaust steam from the engines in the business districts of San Francisco and conducting it to closely adjacent resident districts. He regarded such a system as not generally applicable, the difficulty being the multiplicity of connections. With regard to co-operative heating Mr. Emery thinks there can be no question that if a large number of property owners in a given district would associate themselves together for the erection of a steam plant the enterprise would be remunerative even in a business neighborhood. However, he does not think the profits realized would be such as would warrant an intermedium of promoters and large issues of stock.

The Field for Architectural Work in the South appears to be large. As an example of the activity in building in many of the Southern States, Roanoke, in South West Virginia, may be cited. There are at present in construction in that city three churches, one chapel and 196 dwellings, the aggregate estimated cost of which is stated to be $785,800. Large numbers of these dwellings are said to be built to meet a demand for rents from persons employed in the numerous industrial establishments in the city. Other manufactures are projected and more will soon be in operation, sufficient, it is said, to give employment to several thousand more men. Enterprising young architects might, it would seem, do better than to remain in New York City offices, as in a great many smaller towns they could easily work into business for themselves.

A Notable Addition to the Architecture in Greenwood Cemetery in our neighboring city of Brooklyn, is henceforth to be a new tomb built by Mr. Charles T. Yerkes, a Chicago millionaire who has rapidly accumulated a fortune in street railway oper-

ations in Chicago. This mausoleum is 50 ft., 6 in. long, 23 ft. wide and 20 ft., 6 in. high, and built of crystal granite from Vermont, a stone of great durability and strength. This material is light in color, with a very fine grain. The pure Grecian style has been followed in the design, the structure resting upon a platform which is reached by three steps. At each end are four columns with Ionic capitals and four pilasters. The ceiling is supported by six interior pilasters of marble and is decorated by four panels. The roof is composed of only nine stones, two of which weigh twenty-seven tons each. These stones are interlocked in such manner that it is said the roof could not be removed except by turning the edifice upside down. The sarcophagi, of which there are two, are centrally placed in such a manner as to form an outer and an inner receptacle, the inner being of bronze and the outer of polished granite. The doors of the tomb will be of decorated bronze. This mausoleum, which stands on a conspicuous site, is estimated to have cost, inclusive of the plot on which it stands, the round sum of $50,000.

Bessemer Steel in Architecture is rapidly increasing in use. Its employment in Chicago has perhaps been more extensive than in any other American city. It is about six years since the first steel beams were used in the Chicago Opera House. A large number of buildings have since been erected, into the structure of which steel has entered, more or less. The "Rookery," as it is called, and the Board of Trade buildings in that city are among these, as well as numerous hotels and commercial buildings. A much employed construction has been that of cast-iron columns and steel beams; but steel foundations, window frames, roof trusses and lintels have been used in later buildings. For foundations, ordinary 75-pound railway rails have been employed. In one instance these foundations (which always extend out a greater or less distance into the street past the wall line of the building according to the weight to be supported) are carried out twelve feet beyond the wall line. These steel beams are mostly made at Pittsburg. Carnegie, Phipps and Company, and Jones and Laughlins are the principal manufacturers. The first-named firm is said to make the largest steel beam yet obtainable in this country —24-inch. Smaller beams (15-inch and under) are made by the Illinois Steel Company at their North Chicago Rolling Mills. Steel columns are made at Newcastle, Pa. Steel beams are also made by the Trenton Iron Company at Trenton, N. J. Some steel beams are made at Pottsville, Pa., and Phœnixville, Pa. The recent use of this material—probably destined to supersede cast-iron for all large and tall buildings—has arisen from the fact that steel is amenable to more reliable tests than cast-iron, and is thus better fitted for the construction of the enormously high buildings now so much in vogue in large cities.

The Probable Reorganization and Operation of the Columbia Iron and Steel Company's Works at Uniontown, Pa., by Messrs. Carnegie, Phipps & Company, Limited, of Pittsburg, is announced. Several months ago the Columbia Iron and Steel Company made an assignment, and the works have been idle since that time. An unsuccessful attempt was made to obtain an extension of five years from the creditors. The *Ohio Valley Manufacturer* states that the arrangement with the Carnegie people for operating the plant has not been yet consummated, but little doubt remains that it will be made. The plant of the Columbia Iron and Steel Company, which turns out structural shapes exclusively, is one of the finest in the country, and if operated under conservative management will no doubt realize handsome profits. At the time of the failure the Columbia Iron and Steel Company had some very desirable contracts on hand, one of which was the structural material for the new Masonic Building in Chicago.

A Singular Litigation was the recent suit of Green vs. Archer, instituted in the Queen's Bench Division of the High Court of Justice in England, and tried recently in London. It seems that the plaintiff and defendant had been in partnership as architects for a period of fifteen years and had together designed and su-

perintended the construction of many important buildings. Their partnership was dissolved in October, 1889, and in closing up the affairs of the firm a number of photographs of the principal buildings which had been planned were, in the division of the firm's effects, apportioned to the defendant. Of these the defendant made copies and labelled them as designed by Thomas Archer, Fellow of the Royal Institute of British Architects, framed them and hung them up in his office. He also sent sets of these photographs to prominent public officials. The plaintiff alleged that the publication of these photographs labeled as designed solely by Mr. Archer, constituted a libel upon him, as he was one of the architects who designed and constructed the buildings shown. The Court held that while an action in the nature of an injunction suit might be admitted, the action of Mr. Archer in no way constituted ground for a libel suit, and accordingly he dismissed the complaint.

The Soldier's Monument, unveiled on Memorial Day at Dennison, Ohio, represents a life-size group, in which a soldier, standing by a tree which has been broken by a cannon ball, presents his canteen to a wounded comrade lying by his side. This work is cited as showing the artistic possibilities of the Oolitic stone from the adjacent quarries from which the monument has been wrought. It is stated that the appearance of the group is extremely lifelike, an unusual effect being produced by the soft tint of the stone which gives a much more flesh-like appearance than can be obtained in marble.

The Academy of Medicine in West 43d Street, New York City, is worthy of notice on account of its skillful design with reference to the limited space upon which the building stands. Such good judgment in apportionment of space has been exercised by the architect, Mr. R. H. Robertson, of New York City, that notwithstanding the available space was only 75x100 feet and 2 inches, the building accommodates very conveniently all the departments of the institution. It is a strong building in Romanesque style with a front of Scotch brown stone. The first story contains a large lecture hall and roomy dining, smoking and committee rooms, together with a serving room in connection with the dining-room and porter's hall. A spacious room for special lectures only is located on the second floor with a gallery which overlooks the lecture hall in the first story, and private rooms for other business are also located on this floor. On the third floor is a library and a handsomely decorated reading apartment exclusively for ladies. The stock room of the library has a capacity of 250,000 volumes. The library is finished in ash, with easily accessible bookcases for the use of students. The fourth and fifth floors are occupied with class rooms, toilet and robing-room. On the sixth floor is a room devoted to microscopy and here are also located the rooms for the exclusive use of the librarian. The interior is finished throughout with hard wood stained in various colors and a very harmonious effect has been produced in the treatment.

The National Iron Roofing Association has met a difficulty arising from different standards of plate gauges by the adoption of the Birmingham gauge. A good deal of trouble in the interpretation of contracts has been encountered by the makers of corrugated roofing and iron and steel roofings on account of the use of several different gauges by different firms and companies. An order placed with the manufacturer using a different standard often resulted in misunderstanding, as the goods delivered were not what were supposed to have been bargained for. A good deal of dispute and some litigation having resulted from this want of uniformity in gauges, the National Iron Roofing Association took measures to establish a standard which should be recognized and adhered to by all its members as authoritative. The Birmingham gauge as given in Haswell's Engineers and Mechanics' Pocket Book, page 115, was the standard adopted.

The Present Strength of Glazed Sewer Pipes of Different Sizes was made the subject of a paper read at the June meeting of the Engineering Association of the South, at Nashville, Tenn., noticed in the Depart-

ment of Engineering. The paper presented an account of experiments conducted at the engineering department of the Vanderbilt University to determine the ability of sewer lines and conduit lines made of ordinary sewer pipes to sustain internal pressure without bursting or blowing out the joints. The results are important both to architects and engineers. Three sizes of pipe were experimented with, to wit: 8, 15 and 24 inches diameter. The average internal pressures at which the pipes were found to fail were from 10 to 18 pounds per square inch. It was also found that the pipe and the joints gave way at about the same pressures.

The Clinton Hall Building on Astor Place, which is the future home of the Mercantile Library, has been erected to accommodate 300,000 volumes, of which there are now on the shelves 235,000 volumes. The design of the building comprises all the modern improvements in library buildings. A very ample, light and commodious reading-room, well furnished, has been provided. The library is situated on the two upper floors, which are very lofty and roomy. Both the circulating and reference libraries in this building are considered equal to almost any in the world. The lower floor of the library is the sixth floor of the building, and communication is maintained by constantly running commodious elevators. The reading-room provides all the latest magazines, periodicals and newspapers. The circulating library comprises 200,000 volumes.

Another Notable Addition to the Attractive Club House Architecture of New York City, is to be the new Mendelsohn Glee Club's House, soon to be erected on the north side of Fortieth Street about midway between Broadway and Sixth Avenue. The club has been in existence twenty-five years, and this new building is understood to be the gift of Mr. Alfred Corning Clark, who was at one time a member, and has always been a friend to the club. This having now grown to a membership of 230, and finding its present quarters in West Fifty-fifth Street much too narrow, will find the elegant building, about to be provided through the munificence of Mr. Clark, very acceptable. The architect is Mr. R. H. Robertson of New York, president of the club. The cost is to be $250,000. A description of the building published in the New York *Sun*, July 19th, states that:

"The architecture will be after the style of the French empire. Though apparently but six stories high, the building will be equivalent to an eight story structure. The main entrance is at the west end of the building, while at the east end is an entrance for members. The main entrance leads to a large concert hall, which covers nearly the entire floor space of the building, and will be its principal feature. It will have seating accommodation for 1100 persons, including the gallery, which will seat 380. There is also on the ground floor a general assembly room with doors which can be let down into the basement so as to connect the room with the concert hall and make an additional seating capacity. The stage ceiling is to be in the form of a parabolic curve, and the acoustic properties of the hall will be of the best."

It is said that the ventilation of this building has been made the subject of special study. A plenum will be maintained in the building by means of a centrifugal blower. There will consequently be no inward drafts from doors and windows. In winter the air forced into the building will be warmed by ample box coils. In summer it will be cooled by passing it through ice racks. The building is to be fire-proof, and its exterior will be of terra-cotta brick, with trimmings of brown stone. The members' apartments are to occupy the three upper floors. In the basement there will be a ladies' reception room, a kitchen, pantry, smoking room and a commodious hall for rehearsals. The building will have a frontage of 80 feet on Fortieth Street, and a depth of 100 feet.

The Sanitary Conditions of the large Post Office Building in the City of New York have recently been made the subject of investigation by Supervising Architect, W. J. Edbrooke, and Chief Clerk Frederick Brackett, of the Treasury Department. These gentlemen visited the building on the 15th of July, and there made inquiries as to what temporary sanitary improvements are needed, and also what other repairs are necessary to be made. The

floors and steps of the stairways in this building have been badly worn by the myriad feet which have passed over them, and the building is in other ways somewhat dilapitated.

Books of Interest and Value to Architects, received during the month, are as follows:

"Hints on the Drainage and Sewerage of Dwellings," by *William Paul Gerhard, C. E.* Second edition. New York, William T. Comstock, 23 Warren Street. $1.50 by mail.

In this book are a description and comparison of plumbing, as done years ago, with recent plumbing, and essentials of good drainage and plumbing are pointed out clearly. Illustrations, by engravings and diagrams, of systems, means and appliances are numerous. Errors in practice are indicated. Especially may young architects profit by a careful perusal of this work.

"A Guide to Sanitary House Inspection, or Hints and Helps Regarding the Choice of a Heathful Home in City or Country," by *William Paul Gerhard.* New York, John Wiley and Sons, is another work which treats of all imperfections of site, atmospheric conditions and defects in building, and the means, methods, and appliances by which they may be discovered. The essentials of healthful homes are also discussed. With this book as a guide neither architects or owners need long be in the dark as to the sanitary conditions of either a newly erected or an old house. The point is made that the essentials of healthy homes, aside from external conditions, are related to those features of construction most easily concealed and, therefore, most likely to be overlooked in the inspection of prospective purchases. The book is worth many times its price to any intending purchaser of improved real estate.

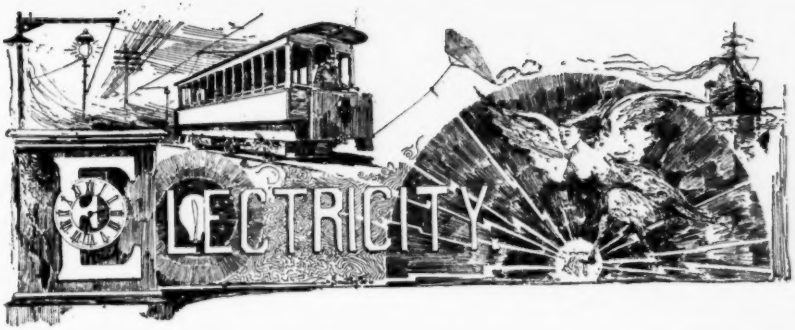
"Recent Practice in the Sanitary Drainage of Buildings," being No. 93 of Van Nostrand's Science Series. "The Disposal of Household Wastes," No. 97 of the same series, and "House Drainage and Sanitary Plumbing," are works by the same author, published by D. Van Nostrand Company, 23 Murray and 27 Warren Streets, New York. Mr. Gerhard is a voluminous and authoritative writer upon these and collateral subjects, and the books noticed ought to form a part of the library of any one interested in the progress of sanitary engineering and construction. These books are all well printed and nicely bound.

The Way Owners Defeat Their Own Wishes was pointed out in an article entitled "Heating and Ventilating Homes," published in the April number of this magazine. A story published in the *Architect and Builder* strikingly illustrates the lessons therein inculcated. The story is as follows:

"Architects have all sorts of clients. We remember a case of an old gentleman who had set his mind on certain improvements which he proposed making on his property. He had fixed his price and consulted an architect, a fair minded man, who advised him fairly and faithfully what he could do and about what it would cost, which, by the way, was above the estimate set by his client. In consequence the plans and the architect were repudiated and a more politic architect chosen, who made the improvements at nearly double the expense named by the first architect."

The journal quoted states, in an editorial which comprises the above quotation, that such cases are so frequent as to disgust honorable practitioners, but it adds that "nevertheless they emphasize the importance of a careful study of costs and methods of estimating them with accuracy on the part of the architect." In our department of civil engineering this month something is said on the subject of civil engineers as arbitrators; and apropos to that, in the editorial of the *Architect and Builder* to which we have referred, we find the following:

"As we have often repeated, an architect is a counselor as well as a designer, and no more important matter comes before him than this question of the cost, in other words, what can be furnished for the money, and it behooves the man who wishes to acquire and hold a successful practice to keep continually posted on this question, so that he may be able to give close estimates on his work, and thus be able to approximate closely to actual cost.



THE Great Electric Lamp Patent Suit—The Edison Electric Light Company vs. The United States Electric Lighting Company—and the decision of Judge Wallace in favor of the plaintiff, are the sensation of the hour in electric circles. The importance with which this litigation is regarded is sufficiently indicated by the issue of an extra, announcing the decision, from the office of the *Electrical Engineer* (New York). It contains the full text of Judge Wallace's decision. It is doubtful whether even those most favorably disposed toward Mr. Edison's claims, could have anticipated or hoped for so strong a decision in his favor as was rendered. The defendants made a strong point of the anticipation of the Edison Patent by Mr. Lane-Fox, and by Mr. Edison himself, in a French patent granted to him in May, 1879. This technical point was, however, in view of the fact that Edison was the first to really produce a durable, practical and serviceable electric lamp, and that this was done subsequently to the granting of the French patent, deemed by Judge Wallace as insufficient to invalidate his claims. The case will not, in all probability, be permitted to rest here, but will be likely to be carried to the Circuit Court of Appeals. The speech of Mr. Grosvenor P. Lowrey, Counsel for the Edison Company, in his review of the testimony, was probably one of the most brilliant efforts on record in a patent litigation. In the opening of the speech he said:

"There was now presented to his Honor the question, whether a man whom Lord Bacon's description clothed with striking aptness, after years of struggle and endeavor, and in full view of the great benefits conferred by him on mankind, could by a petty parsing and spelling of things; a subtle analysis of words and sentences composed in a patent solicitor's office; and especially words devised touching a subsequent application, lose the invention he had given to the world. Mr. Edison was a character quite unique and unprecedented in the history of the art. No wonder he had startled the idiots of the schools, and excited the animosities of men who teach to unresisting boys the knowledge, as well as the errors, found in books."

With Reference to Some of the Experts called by the defense as witnesses to support their view of the case, and also with reference to some well-known electrical authorities who predicted that Edison would fail in his efforts to subdivide the electric light, as he stated he thought he could do, he made use of the following caustic language:

"They had written across the path 'no thoroughfare,' and had signed it 'Mathematicus.' These great authorities in electricity and mathematics do not seem to be able to get outside of their figures and their equations. Professor Cross and Professor Morton had professed to be able to see what was not invention in a machine, although there was not in this case, nor probably elsewhere in the world, evidence which would convict either of those gentlemen of the possession of inventive capacity enough to hang a tin dipper on a pump.

"Yet they had been called up with their pencils and their little pads to figure out that an invention like this, for which the whole world had been waiting, was after all no invention at all. It was difficult to select, there was so much of it, but Professor Silvanus Thompson was a striking example of how 'away off,' as the phrase was, all these people had been, about what was needed

to make this light, and how Edison was going to do it."

The State of the Art at the time of Edison's invention as shown in this case and as stated at length in the decision of Judge Wallace, was as follows: The practical subdivision of the electric current and its conversion into lights comparable with those of ordinary gas jets had not been done prior to 1879, and there was no known practical method of doing it at that time. The known devices were the arc lamp and the incandescent lamp, in the former of which the electric current leaps an air gap or space between two carbon conductors, a portion of its electromotive force being converted into heat and thus rendering the terminals of the conductors luminous. In the incandescent light a portion of a continuous conductor is made incandescent through heat generated by the resistance of the conductor or some limited portion of it. The arc lamp was used particularly in streets, open places and large halls, but it was too concentrated and powerful for use in rooms of small dimensions.

Electricians were looking at that time to modify the features of the arc lamp as a means of supplying lamps for rooms of small dimensions; and only two, Lane-Fox in England, and Mr. Edison, had expressed any belief that subdivision might be better accomplished by the incandescent lamp, using a conductor which should have the united qualities of high resistance and small radiating surface at the luminous part. Three patents had been granted to Lane-Fox prior to 1879, in which the advantage of such lamps had been set forth, besides the one above named granted to Mr. Edison in France. It appears that the knowledge of how to make conductors of the character required was well enough known to electricians at that time. What they did not know, was in what way a lamp could be constructed in which such a conductor would have strength and durability sufficient to render it of practical utility. Neither Mr. Lane-Fox nor Mr. Edison had yet succeeded in doing this. They had met with serious difficulties arising from properties of different materials with relation to the electric current. Platinum brought critically near to its fusing point became luminous, but it was difficult to hold the temperature with the exactness required to prevent its fusion. Carbon combined so readily with oxygen at high temperature that it would last only for a brief period. Judge Wallace regarded the Geissler tube, patented by King in England in 1849, as not being a lamp in the true sense, because it had no burner, or incandescent flame, or luminous conductor. In 1879 the *Telegraphic Journal* published an article from Mr. Schwendler which asserted that, unless a conductor of electricity could be found having a much higher melting point than platinum, a specific weight and specific heat much lower than platinum, and which would have also the property of resisting combination with oxygen at high temperature, the principle of incandescence could not be expected to be used for ordinary illumination.

The Patent Granted to Sawyer-Man in 1878 set forth the difficulties in constructing lamps in such manner as to permanently exclude oxygen from the conductor. One of the principal difficulties was in making the lamps sufficiently tight, and if some gas other than oxygen, as nitrogen, was introduced into the globe, at each heating of the lamp, when used for lighting, a portion of this gas would be expelled through the leaks and replaced by ordinary air upon the cooling of the lamp, so that it became only a question of time when the oxygen so gaining access to the lamp would destroy the conductor.

The Gist of Edison's Invention is expressed clearly in his specification. Three principal points may be noted: First, he adopted the method of using a conductor which offered great resistance to the passage of the electric current at the same time presenting a very small surface from which radiation could take place. Second, he proposed to place such a burner in a vacuum so nearly perfect that oxidation and injury to the conductors from the atmosphere would be prevented. Third, he described a method of manufacturing carbon conductors of high resistance,

suitable to giving light by incandescence, and a method of obtaining perfect contact between the metallic conductors and the carbon conductors so as to render them one continuous conductor; and all of these objects he practically attained by joining his carbon conductors to platinum wires inserted through glass and hermetically sealed therein by exhausting the bulbs and hermetically sealing them while so exhausted. After a very high vacuum had been produced he made the bulbs so tight that the difficulties hitherto experienced in the access of oxygen to the interior, consequent upon the use of cemented joints, etc., were removed.

The Specification is very complete. There is perhaps some vagueness in the claims and there is little doubt also that the invention was very much farther reaching in its scope than Mr. Edison or his patent attorney had any idea of at the time his specification was prepared. With regard to this point Judge Wallace says in his decision:

"It is of little import what Mr. Edison or his patent solicitor may have thought about the meaning of the claim during the pendency of the application for a subsequent patent, or that Mr. Edison may have supposed a resistance as high as 100 ohms in the burner would be required for use with the means of distribution which he expected to employ with his system of lighting. There are many adjudicated cases in which it appears that the inventor builded better than he knew; where a patent has been sustained for an invention the full significance of which was not appreciated by the inventor when it was made. In the case of the Bell telephone patent there was great room for doubt whether the speaking telephone had been thought of by Mr. Bell when he filed his application for a patent, but the Court said: 'It describes apparatus which was an articulating telephone, whether Bell knew it or not.' 88 Blatch., 532."

Many improvements have been since made; and it is admitted that the electric lamp of to-day is far superior to any which could have been made by following the directions given in Mr. Edison's specification; but Judge Wallace maintains that lamps made solely from the description given in the patent will and do succeed, and he regards it as "impossible to resist the conclusion that the invention of the slender thread of carbon as a substitute for the burners previously used opened the path to the practical subdivision of the electric light." In another part of his decision Judge Wallace states that what Edison "actually accomplished was to unite the characteristics of high resistance, small radiating surface and durability in a carbon conductor, by making it in a form of extreme tenuity out of any such materials as are mentioned in the specification, carbonizing it and arranging it as he had previously arranged his platinum burner in an exhausted bulb made wholly of glass and sealed at all points, including those where the leading wires entered, by the fusion of the glass." Any one who has followed the evidence in this case and whose mind is not biased, could scarcely arrive at any other conclusion than this, in view of which the decree for an injunction and accounting ordered by Judge Wallace seems eminently just.

The Effect of Electricity upon Plant Growth has again come up for discussion, and it is more than likely that experimental research upon this subject guided by increased knowledge will soon solve the principal problems connected with it. If, as some electricians now seem inclined to believe, electricity and light are one and the same force, there is good reason to expect that electric conditions may be found intimately connected with the growth and development of plant life as light is known to be. The potent influence of the electric current upon chemical reactions also leads naturally to this expectation, since the same laws must hold good in nature's laboratory as in our much more limited chemical operations. Experiment and research in this line date back at least to the first half of the eighteenth century. A considerable number of scientific men of greater or less eminence have concerned themselves with it, and the literature of the subject is extensive. The results obtained by different investigators have not been uniform. It is likely that the same electrical treatment is not adapted to all kinds of plants any more than the same climate or soil. This consideration may

help to explain the contradictory results of "electro-culture," as it is called in modern times. Public interest in the subject has been quite recently aroused by an account in the English papers of the use made of the electric light in preserving the health of delicate plants during transportation from the West Indies to the Botanical Gardens at Kew; and this has also brought prominently to notice the recent investigations of Lemstrom in the physical laboratory of the University of Helsingfors. These experimental researches have nearly all been prosecuted during the last decade, and they strongly indicate that electric force is some day to become a potent agent in the growth of crops. Our space will not permit a resume of these experiments. Those interested sufficiently to desire fuller information may find such a resume in Sci. Am. Supplement No. 806 in a translation of a very interesting article from the French of H. Fargas, first printed in *Les Inventions Nouvelles*.

The Deleterious Action of Lightning Stroke upon trees is, in general, apparently limited to a greater or less mechanical injury. Passing through any American forest, one can discover trees which have been mutilated by the action of lightning, as shown by their scars or by the yet unhealed characteristic furrows in the trunks, but which seem to be living and growing vigorously, and to have sustained no vital injury. It chanced to the writer in the summer of 1890 to witness the effects of lightning stroke upon a magnificent elm—one of the finest specimens of its kind—growing in majestic beauty in a wide open field at a considerable distance from any other tree. During a violent thunderstorm this tree was struck and a furrow was ploughed out of one side of its trunk in the usual manner. It was at first supposed that this was the extent of the injury; but it soon became apparent that the vitality of the tree had suffered. Its immense mass of green foliage began to shrivel. This was not local, that is to say, on the damaged side only; every part of the tree exhibited the same phenomenon. Next, the color of the leaves began to fade. In a few days every leaf was yellow, and it became evident that the tree had received its death-blow. This tree could not have been less than 80 feet in height, and its trunk would probably have measured from 90 to 96 inches in circumference.

A Reminiscence of Michael Faraday, which we do not recollect to have seen elsewhere, is given, among others, in an English paper called the *Referee*. The great electrician and scientist was of the faith known among Protestant sects as Sandemanian, and was one of four elders of a Sandemanian chapel, the others being respectively a butcher, a gasfitter and a linen draper, of whom the butcher, whether on account of his eloquence or orthodoxy the story does not explain, was the preferred preacher. It happened that in 1856 Faraday on his own confession that his scientific researches had unsettled his belief, was suspended; or, in the Sandemanian way of expressing it, was "put away" from them. The story narrates further that:

"The gasfitter and butcher were shocked and stern. They all prayed for him, asking that light might be sent to his darkened brain. The prayers were answered. After a separation of some months, the great Michael Faraday—the man whom all the world delighted to honor—came back one day to the little meeting-house in Paul's-alley, and, standing up before the little congregation—the Sandemanians were a very small body—made full confession of his error with tears in his eyes. Every one wept, and a blessed peace fell on the little meeting-house. Faraday, Mr. Sims remembers best as an elder, though he often met him at the elder Mr. Sims' house at Peckham. He had a very winning way with children, and they all liked him. The Sandemanians liked him very much as a man, but they preferred the butcher as a preacher, and they considered it a terrible thing for a good man to devote himself to such doubtful subjects as electricity, instead of reading the Bible and being satisfied with things as they were."

A New Telephone, called the Collier Audible Telephone will, in view of the expiration of the Bell telephone patent and also on account of its remarkable character, be likely to produce a revolution in the telephone business. This instrument is the invention, not of a professional electrician,

but of a Congregationalist minister of Sydney, New South Wales,—Rev. Arthur P. Collier. The results reached by this skillful amateur have been such that he has temporarily relinquished his profession and has gone to England for the purpose of introducing his invention. It is said that he has met with some success there and that a syndicate has been organized to further the interests of the invention. Without going into the details of construction, which could only be well comprehended by professional electricians, it will be sufficient to say here that the volume of sound is stated on the very best authority to be so much louder and more distinct than that of telephones heretofore used, that it entirely overpowers that from a Bell receiver on the same circuit. One paper states that a comparison of sound between the instruments is like that of shouting to whispering. The sound is stated to be of sufficient volume to fill a small room, and it is not necessary to place the telephone close to the ear to hear a communication. When the ear is placed too close to the instrument the sound is so loud as to be actually painful. The *Electrical Engineer* of June 26th. states that Mr. W. Fereday Bottomley, Manager of the Telephone Company of Ireland has made a number of tests under varying conditions with the instrument, with and without transmitters, and he gives it as his opinion that the Collier instrument is superior to any other yet introduced. This journal states that Mr. Bottomley has avowed his belief that with this instrument and without the aid of a microphone, conversation can be carried on with distinctness and ease over a line of 5000 miles. Another test has been made by William E. Heys, M. I. E. E., of Manchester. This gentleman estimates the loudness as from three to four times greater than that of the best examples of the "double-pole Bell" and "Ader" instruments. He states that in arranging resistances he has been unable to find any measurable resistance which can exclude the sound with the Collier telephone, although he employed pure water 150 centimeters, 100 centimeters of linoleum, 400 centimeters of thick pile carpet, all dry, and a human body. He also insulated the observers by thick glass with only a small reduction of the sound. It is stated further that an order of 500 of these telephones has been given on their merits by one of the large English railway companies. With regard to Mr. Collier it is stated that although he is not a professional electrician yet his work indicates his ability to carry out his invention in an entirely satisfactory manner.

Electrical Communication with Light Houses was spoken of as the question of the hour in the June number of this magazine. On the 12th of July a large deputation from the Associate Chambers of Commerce waited upon the President of the Board of Trade in London, to urge the importance of telegraphic or telephonic communication between the lifeboat and coast-guard stations and the light houses and light ships. Sir Michael Hicks-Beach, the president, indicated to the deputation that he was disposed to repeat on a more extended scale the experiments which had been previously tried at the Sunk Light Ship. If, however, communication on an extended scale, such as was outlined by the deputation, is desirable, it would be necessary to have it authorized by the treasury and admiralty as the board of trade had at their disposal only the mercantile marine fund.

Electric Launches, Yachts and Pleasure Boats are rapidly increasing in number. A new electrically propelled yacht, the *Electron*, was recently tried on the Hudson River with exceedingly satisfactory results. The vessel is 75 feet long, with an iron hull. She is driven by power derived from 376 accumulator cells which develop 15 h. p. The current is controlled from the pilot house by switches placed therein. A single charge of the accumulators is sufficient for a run of 10 or 12 hours. It is thought that the propeller screw is too small for the boat and that an increase of its diameter will give a higher speed, say 12 or 13 miles an hour. On the Thames River, in England, two new electric boats have been launched. One of these is called the *Glow Worm*. It was designed for the famous soap-maker, Mr.

Pears. It was built at the Woodhouse & Rawson Strand Electric Launch Works at Chiswick, as was also the other yacht alluded to, which is called the *Myiomi*. The *Glow Worm* is 53′ long, 7′ 2″ beam, and has a draught of 2′ 6″; her displacement is 5¾ tons. She is said to be a beautiful boat, built entirely of bright mahogany with teak fittings. Her cabin is placed amidships. The accumulators from which she derives her power are arranged underneath the seats. The motor is in the afterpart of the boat. Her propeller has a speed of 600 revolutions per minute. The *Myiomi* is 35′ long, with 5′ 6″ beam, and a draught of 18″. Her displacement is 3¼ tons. Her hull is built of mild steel with teak fittings, and the arrangement of her accumulators is like that of the *Glow Worm*. She is said to have a speed of 9 miles an hour. We also hear of a pleasure boat to be driven by electricity developed from a storage battery and to be built of aluminum. D. J. Cable of Pittsburgh, Pa., is the designer. He says that his boat will carry from 4 to 6 persons and that it will not weigh more than 60 or 70 pounds. A feature of the battery of the boat is said to be that aluminum is used instead of lead.

The Reorganization of the Westinghouse Electric and Manufacturing Company is in progress, and it is stated that negotiations have been brought to such a point that the preliminary arrangements are nearly finished. The stockholders are said to have nearly or quite all assented to the proposed plan of re-organization. Meanwhile the shops of the Company have been running regularly, and doing their full quota of work. A large number of electric street railway companies are equipped or are having their cars equipped with the Westinghouse system. The management of the Company during its period of difficulty has been admirable, and there is no doubt that under the new organization it will have a brilliant future.

The Royal Agricultural Show at Doncaster, England, illustrates how intimately electricity is now connected with every phase of industrial progress. The oil engines exhibited there have attracted attention with reference to their use in electric lighting, etc. It appears that there is no doubt of their availability for this purpose. There are many places where neither the use of steam or gas is possible, and where the only present means of illumination is the burning of oil in lamps. By use of the oil engines instead of burning the oil in lamps, it may be burned for the purpose of generating mechanical power, and this may be converted into an illuminating agent with the means of an electric circuit and the electric lamp. The engine which more than all others attracted attention is described in another place in this magazine. However, it is quite evident that there is yet a great deal of room for improvement in this class of engines, and that their future will not depend upon their present state of development.

Both American and Foreign Papers are noticing with approval the exhibition of the American Otis Elevator Company of New York, at the Frankfort Electrical Exhibition. The current for running these elevators may be taken from the same mains as that for electric lighting. The elevator at the exhibition is constructed on the same plan as that employed by the company in New York. The manipulation of the switches is effected by a hand-lever, but the more customary rope may be also used if desired. An automatic resistance and other safety applicances, as well as an automatic arrangement whereby the current is prevented from running through the motor continuously, and thermostats which indicate if any of the bearings heat, are features of this machine.

The American Exhibitors at the Frankfort Electrical Exhibition are the Thomson-Houston Company of Lynn, Mass., exhibiting dynamos and electric motors and various kinds of apparatus for mining work; the Edison Company through the Berliner Allgemeine Elektrizitäts Gesellschaft; the Edison United Phonograph Company of New York; the Westinghouse Company; the Weston Electrical Instrument Company of New York; and, as noticed above, the Otis Elevator Company of New York. The Babcock and Wilcox Company of New York are indirectly represented by a boiler built in England.

A STOCK Company with a capital of $2,000,000 has, on the authority of the Grand Rapids (Mich.) *Telegram*, been organized at Big Rapids for the purpose of purchasing and developing a tract of 26,000 acres of coal and timber lands lying on the Log Mountain and Clear Creek between the cities of Pineville and Middlesborough, Bell County, Ky. The price to be paid for the property is $1,300,000—leaving $700,000 stock in the treasury, a portion of which is to be sold to provide means for building railroad, coke ovens, etc. The prospects of the new company are considered very flattering. The timber on the track is estimated at 350,000,000 feet, consisting of yellow poplar (whitewood), white oak, chestnut, red oak, chestnut oak, hard maple, ash, hickory, cucumber, locust, basswood, cherry and black walnut—in quantities about in the order as named—and will doubtless yield more than the cost of the entire property. Ninety per cent. of the land is virgin forest—carrying, according to the estimates of various experts, from 15,000 to 16,000 feet (average) per acre of the above mentioned species of merchantable timber—in addition to a considerable growth of beech and hemlock—valued at present only for local and mining purposes. The timber is of an unusually healthy and large growth, and on completion of the railroad (14 miles) can be manufactured and marketed at a very handsome profit. From the *Manufacturers Record* we learn that the principal value of the property consists in its coal deposits. The company acquires almost the whole of the famous "Log Mountain" district, which is now considered to be the centre and richest portion of the whole southern Appalachian coal field. They have about 30 feet of coal veins, of good workable thickness, one above the other, all above drainage and with a gentle dip toward the clear creeks of which they own about 18 miles in length. The analyses show coals of exceedingly rare purity, especially for coke-making, and also for steam and domestic uses. The lower vein, only 80 feet above the creek level, is 86 inches thick, being 52 inches solid, and magnificent cannel coal, and 34 inches bituminous, with only a one-inch parting (mineral charcoal). This vein is of great value, as every foot in thickness means 1000 tons to the acre. Above this vein are several of about four to five feet in thickness, all so situated that they can be mined with one inclined track, and all dipping sufficiently toward the creek, so that the coal and water will come out by its own gravity, no hoisting or dumping machinery whatever being required, empty cars being hauled into the mines by mules. The company proposes to lease its coal mines, farms, clay beds and quarries on royalty, and sell its stumpage, and proposes to offer special inducements for the location of furniture and other woodworking establishments, tanneries, coke ovens, iron furnaces, etc. This is the nearest coking coal to the great iron deposits of North Carolina. It is said several beautiful town and village sites, will be laid out and developed as growth and demand may require. The company will control all the water supplies for manufacturng and domestic uses, and purposes carrying out a systematic development of all the resources of the property.

The Output of Pig Iron in the United States for 1891, according to present indications, seems likely to fall far below last years' figures. The *Manufacturers' Rec-*

ord has approximately estimated, from statements obtained from what it considers to be reliable sources, the total output North, West and South for the first six months of the present year, and has placed this in comparison with the output of 1890 as given by the American Iron and Steel Institute.

	1st half 1890.	2d half 1890.	1st half 1891.
Total North and West.....	4,154,145	4,199,424	3,162,500
Total South....	953,630	999,829	835,300
Total U. S...	5,107,775	5,199,253	3,997,800

Scrutiny of these figures will show that of last year's output the South produced over 23%; so far during the present year the output of the South is 26% of the total product.

A New Steel Making Process was exhibited on the 12th of June at the Sheffield Technical School, England. This process has been wrought out by Prof. Arnold, who conducted the operations on the occasion named. According to a correspondent of *Engineering*, London, the operation was very successful; the ingots teamed being of a composition never previously heard of in the history of steel. "This process, which is the outcome of the researches recently made by Professor Arnold, opens up possibilities for the cheap and rapid manufacture of high-class steels which are likely to bring about a revolution in the present processes of manufacture. The process consists in practically removing the whole of the impurities from Swedish pig-iron, with the exception of the exact proportion of carbon required for a given purpose, thus obtaining the ideal carbon and iron steel, homogeneous in structure and absolutely free from blowholes, these results being obtained without the presence of more than mere traces of manganese and silicon, and also without the use of iron ore. The average time occupied by this process in the conversion of a ton of pig-iron into the highest class of steel yet made will be about three hours, the fuel used consisting of about half a ton of rough slack. The new furnace, together with the general plant, was designed to Professor Arnold's specifications by Mr. B. H. Thwaite, C. E., of Liverpool, and is intended to produce three tons of steel per day of 24 hours. The cost of the really necessary portions of this plant would, we understand, be no more than that of an ordinary twelve-hole crucible furnace. Much can hardly be said at present as to the capabilities of the process, but it is anticipated that the range of the metal produced will vary from what would be considered wrought iron to the hardest tool steel."

The Recent Discovery of Diamonds and Other Gems in Lapland is turning attention that way in the hope that although the minerals yet found have been of very little value on account of their extremely small size, they indicate a probability that somewhere, further up the streams in which they have been found, valuable deposits may be discovered.

The Status of the Charcoal Pig Iron Industry is editorially discussed in the *Iron Age* for July 9th. According to this it appears that never before has Lake Superior charcoal pig iron sold at so low a price as during the past spring. The makers of high grade irons have suffered as well as those who have recently entered into the business and have been obliged to compete solely on a basis of price without regard to other considerations. The journal named points out that, under conditions prevailing this year, the charcoal iron market could not have been otherwise than depressed, and calls attention to the fatuity of those who not only built new furnaces last year but rehabilitated old furnaces long abandoned. It also emphasizes the fact that the cost of producing charcoal pig iron cannot be varied as can that of coke iron, and that the point is reached with Lake Superior charcoal iron below which it will be impossible to go further. It would seem from this review of the business that although charcoal iron will continue to be to some extent preferred for certain lines of manufacture, as malleable castings and car wheels, the manufacturer of this kind of iron must continue to suffer in competition with coke iron, and that those who find themselves unable to compete will be forced to gradually

withdraw from the business. Only after this process of weeding out has rendered production commensurate with actual requirements will the remaining owners of charcoal furnaces be able to do a profitable business.

Vertical Bending Rolls designed by William Sellers & Company, of Philadelphia, for the Newport Ship Building and Dry Dock Company are described in the *American Machinist* in its issue of July 2. These rolls are adapted to bending steel plates ten feet in width and 1½ inches in thickness. The material of the rolls is forged steel. The bending roll is 18 inches in diameter and the side rolls are 15 inches in diameter. The bending roll is the principal driving roll, but all three rolls are positively driven by a pair of independent reversing engines. One of the principal aims of the design has been the avoidance of what is known as calendering action upon the plates in passing through the rolls. The device by which this is effected is a positive clutch in the train of gearing for the side rolls, this clutch having sufficient lost motion to allow for the maximum effect of calendering. Another feature of the design is the substitution of adjustment in the side rolls for adjustment of the middle roll. The adjustments may be made for bending plates either straight or in wind.

The Collection, Preparation and Exhibition of Mineral Specimens form the subject of a very interesting article written for *Mining Industry* by Albert Williams, Jr. Mr. Williams asserts that simply a number of chunks of showy ore are not sufficient to represent even a single mine, but that fresh, sound specimens should be obtained of each wall rock and of all variety of country rock met in the mine workings or in the immediate neighborhood of the mine; of dikes and horses, if any encountered; of ore from croppings down to the water level and below it, taken from a large number of points and selected with reference to the finest, most characteristic and the average run of mine of the stopes from which specimens are taken. Low grade specimens and others showing any unusual peculiarities ought to be secured. He also suggests the propriety of making sets of concentrates or other products. There may be also interesting minerals in the account which should not be omitted. Moreover, the specimens of the ores and minerals should be properly dressed both for the sake of neat appearance and for convenience in handling. They should also be marked in such a way that there can be no danger of confusing their labels, the marks indicating, either in themselves or by correspondingly numbered labels or numbers in a catalogue, the precise place from which taken and possibly other important things. To sum up, if it is worth while to have a collection at all, it is worth while to have it in good shape. The purpose of Mr. Williams' article is to give simple, plain directions for collecting, selecting and dressing, determining, marking, labeling and exhibiting specimens, and his article is altogether so good as to cause regret that we cannot, on account of its length, copy it entire in this department.

A Delegation of Sixty Welsh Tin Plate Workers will, it is said, come to this country to investigate the prospects for tin plate workers in the United States. This action has resulted from the stoppage of the Welsh tin plate works, at which action the operatives are indignant. It is stated that American agents are active in Wales purchasing the latest machinery and offering tin plate workers double the wages they have been accustomed to receive.

The Discovery of Sperrylite at Sudbury, Ontario, was mentioned in the April number of this magazine. At this place large deposits of nickel and copper exist. As to the extent of the nickel and copper deposits the [Hon. A. S. Hardy, Commissioner of Crown lands, stated in a recent speech that the bounds of the nickel bearing region are not known, but they certainly embrace an area of not less than 70 miles in length by 50 miles in breadth or an area of about 2,250,000 acres. New developments have taken place and new discoveries have been made beyond Sudbury, as far as Lake Wanapitae on the shores of the Georgian Bay. The large supply of nickel which appears to be in sight in this

region has directed attention to the possibility of using it more extensively than has hitherto been done, and for other uses than those to which it has hitherto been applied. It is stated that an offer has been made by a French firm to take the output of the mine in Sudbury for an unlimited number of years.

A New Alloy of Copper and Antimony, the color of which resembles gold, is announced. The discovery is credited to Herr T. Hedd. The alloy is stated to be composed of six parts of antimony and one hundred parts of molten copper, a flux of wood ashes and magnesia and carbonate of lime being employed. It is stated that the alloy can be rolled, filed and soldered like gold, and that antimony or acid vapors do not change its color. Its tensile strength is alleged to be much greater than that of gold and its cost is about 24 cents a pound. Nothing is said in the announcement of the effect of sulphur, which is the re-agent mostly concerned in the tarnishing of such alloys.

The Shipments of Ores from the lake ports up to July 1 of the present year are stated by the *Marine Review* to be but little more than 25 per cent. of what they were last year up to the same date. The journal quoted states that the railway companies handling the ore at Escanaba and Marquette have refused to give information regarding the movement from these ports during the present year, but the decrease is nevertheless very apparent.

Mining Operations in the Sewanee Coal Seam was the subject of a very interesting paper read by Mr. J. J. Ormsby, Superintendent of the Thomas Mines of the T. C. I. & R. R. Co., Whitwell, Tenn., on the evening of June 11th, before the Engineering Association of the South, the meeting of which on that date is noticed in the Department of Engineering. Mr. Ormsby's paper was devoted to the general description of the character and workings of the Tracy City and Whitwell collieries of the Sewanee coal seam, preceded by a description of the logical formation of the region. The Sewanee mines are located at Tracy City, Grundy County, Tenn., and have been in operation since 1886. 5,000,000 tons of coal have been mined and 1,400,000 tons of coke made since operations commenced. The coal taken out averages only 7.52 per cent. of ash and 1.8 per cent. of sulphur. The mines are worked by the single entry system and the natural ventilation has usually been sufficient. Recently erected furnaces have been added, however, to improve the ventilation. The Thomas mines are located on the same seam at Whitwell, Miriam County, Tenn. and have been in operation since 1888. The output since that date has been 450,000 tons of coal, and 70,000 tons of coke have been made. Mr. Ormsby stated that the coal from the Thomas mines is much firmer than Tracy City coal that it has no cleavage or conchoidal fracture, but breaks into rough, irregular lumps. The thickness varies from 4 inches to 7 feet or averages about 3 feet. The mine is worked on the double entry plan, and the split system of ventilation is employed. Neither in this mine nor in the Tracy City mines has fire-damp ever been encountered.

Further Large Investments of English Capital in this country are strongly indicated. A despatch from London to the New York *Journal of Finance*, states that a syndicate allied with Paris interests has sent representatives to the United States with authority to invest $28,000,000 in gold, and one of the heads of the Rothschilds is stated to be interested in this investment. The Duke of Marlborough, whose article on "American Railways and Their Management" was reprinted in the June number of this magazine, is stated to be about to visit America again, bringing with him a large amount of capital for investment in the Southern States.

Steel Armor Plates have again been made the subject of government tests at Annapolis, with astonishing and important results. The plates were all steel containing 0.25 per cent. of carbon and were treated according to the Harvey Process. They were made by Carnegie, Phipps & Co. They were three inches thick—the same as those submitted to a former test. It will be remembered that the latter had a higher percentage of carbon and that they cracked under the blows of the pro-

jectiles. The plates, low in carbon, last tested, were each struck fourteen times by forged steel projectiles of the best kind, fired with sufficient initial velocity to drive them entirely through ordinary steel plates four inches thick. In this case, however, it was the projectiles that suffered. The plates were practically unharmed; while the projectiles were each and all shattered by the impact. This result is considered nearly or quite as good as was obtained with the nickel steel plates treated by the Harvey process, tests of which were mentioned in our April number.

The Phosphate Industry, that is to say the mining and preparation of natural phosphate of lime for market, is well described and reviewed in the *Engineering News* of July 18, that journal drawing liberally from other publications for materials for its comprehensive presentation of the subject. It is safe to say that the importance of this industry is known to a very small minority of the general public. From the *Manufacturers' Record* the following statistics of the industry are taken:

Year.	Land rock.	River rock.	Total.
1868–70.....	18,000	1,989	19,989
1871.....	33,000	17,655	50,655
1872.....	38,000	22,502	60,502
1873.....	45,000	45,777	90,777
1874.....	43,000	57,716	100,716
1875.....	48,000	67,969	115,969
1876.....	54,000	81,012	135,912
1877.....	39,000	126,569	165,569
1878.....	113,000	97,700	210,700
1879.....	102,000	98,586	200,586
1880.....	125,000	65,162	190,162
1881.....	141,000	124,541	265,541
1882.....	190,000	140,772	330,772
1883.....	226,000	129,318	355,318
1884.....	758,000	151,243	409,243
1885.....	224,000	171,671	395,671
1886.....	294,000	191,194	485,194
1887.....	230,000	202,757	432,757
1888.....	260,000	190,274	450,274
1889.....	250,000	212,101	462,101
1890.....	300,000	217,149	537,149
Total.....	3,531,000	2,434,557	5,465,557

"At the average selling price of this rock—$6 per ton—the value of the crude rock already mined has been $32,793,342.

"About 30 companies are engaged in mining, with a total nominal capital of about four and one-half million dollars. Nearly all the river rock is shipped to Europe. The land rock is largely used by local manufacturers of superphosphate. The total output of superphosphate from the 20 or so works now in operation, from September 1, 1890, to June 1, 1891, was 278,456 tons, representing a cash value of $4,175,500."

The Production of Phosphate in South Carolina, for the year 1891, is likely to fall considerably below the figures given above, one of the largest producers—the Coosaw Mining Company having become involved in a litigation with the State. The *Engineering News* has printed the history of this suit from which it appears that "the Legislature in 1870 gave an exclusive franchise for 21 years for mining phosphate rock in the navigable waters of the State. The Coosaw company secured the exclusive right to the Coosaw River district, claimed to be the most valuable known bed of phosphate in existence. In 1890 the company mined 107,000 tons of rock, valued at about $750,000, or nearly one-fourth the total output. It is claimed that the total cost of production to the company was less than $4.25 per ton (including a royalty of $1.00 per ton paid to the State). This, it will be seen, leaves enormous profits. When the royalty of $1.00 per ton was established in 1876, the mining company claims that the franchise was made perpetual. The State claims, on the other hand, that the franchise expired on March 2, 1891. A State Phosphate Commission was appointed and prepared to lease the Coosaw company's territory to other parties; an injunction was secured from the United States Courts, however, and mining in this territory is therefore at a standstill for the present. This reduces the output of river rock nearly one-half, and gives an excellent market to the newly established producers in Florida."

The Pig Iron Output of the Cleveland District, England, for June is given in the returns for the month of the Cleveland Ironmasters' Association printed in *Engineering* (London), July 10th. These figures show that, at the end of June, ninety furnaces were in operation as compared with 104 at the end of June, 1890. The number of furnaces on Cleveland pig iron at the end of the month was 58, and the number on hematite 32. The make of

Cleveland pig iron in the district was 125,832 tons, being an increase of 1926 tons, on the previous month. The make of other kinds of pig (including hematite, spiegel, and basic) was 87,213 tons, or a decrease of 5562 tons on May. The total make of all kinds was 213,045 tons, a decrease of 3636 tons on the previous month. Makers' stocks of Cleveland pig iron in the port of Middlesborough at the end of the month amounted to 116,039 tons, being a reduction of 11,181 tons as compared with the end of May. Outside the port the amount held was 9531 tons, or a decrease on the month of 2286 tons. The total for the whole district was 125,570 tons, a decrease of 13,467 tons on the month. In makers' stores 1589 tons were held at the end of the month, against 1820 tons as per the previous returns, a decrease of 231 tons. In the public stores the stocks of pig iron amounted to: North-Eastern Railway Company, 1067 tons, a reduction of 300 tons as compared with the end of May; Connal's, 140,056 tons, being 14,487 tons above what they held at the end of May. The total stocks held under all heads on the 30th June reached 268,282 tons, or an increase of 489 tons, as compared with the end of the previous month.

The Number of Welsh Blast Furnaces in blast at the end of June, as we learn from the same source as the above, was 4, as compared with 4 at the close of March, 1891, 4 at the close of December, 1890, and 5 at the close of September, 1890. The number of furnaces in blast in South Wales at the close of June, 1891, was 31 as compared with 36 at the close of March, 1891; 37 at the close of December, 1890; and 37 at the close of September, 1890. The Anthracite Iron and Steel Company. Limited, is building a furnace in Carmarthenshire, and the Dowlais Iron Company is building another in Glamorganshire."

The Cost of Pig Iron to manufacturers at Bessemer, Ala., is stated by the *Manufacturers' Record* (Baltimore) to be $7.50 a ton. That journal questions how Northern manufacturers using pig iron as a raw material can compete with those located where iron can be produced at this low figure. It has been stated that the De Bardeleben Coal and Iron Company recently made a sale of 40,000 tons at $10 per ton. It should be added that while the company confirms the fact of the sale, they deny that the price was as low as $10 per ton. The circumstances, however, point to the fact that if the price was not as rumored, it was near it, and might well enough have been exactly that, still leaving a very handsome profit, if the cost of production is accurately stated.

A Patent Suit, nearly or quite as important as that of the Edison electric lamp litigation, is now in progress over the manufacture of pure aluminum. It is that of the Pittsburgh Reduction Company *vs.* the Cowles Electric Smelting Co. An injunction restraining the defendant from manufacturing pure alumina having been for the second time applied for by the plaintiff, it has just been denied by United States Judge Ricks of Cleveland, Ohio. United States Judge Swan of Detroit has granted to the defendant a 60 days' extension of time for taking testimony, assigning, as a reason therefor, that some of the most important points ever raised in any patent suit in a Western court are comprehended in this one. The litigation appears to be a legal struggle for the acquisition of a monopoly of the aluminum manufacture.

The Output of Manganese in the United States for the census year amounted to 23,927 tons. The larger proportion of this output was obtained from Crimora, Va., Cartersville, Ga., and Batesville, Ark. Some new mines have been opened up in Vermont, Virginia and Georgia which are expected to be productive.

The Exports of Coal from Belgium in the first four months of this year amounted to 1,486,704 tons, as compared with 1,430,017 tons in the corresponding period of 1890. In these totals the exports to France figured for 1,255,219 tons and 1,193,839 tons respectively.

Clearances of Iron and Steel from Middlesborough, England, for June, show a heavy decrease. They were 4319 tons less than in May of the present year, and 4114 tons less than the shipments for June, 1890. Shipments of manufactured iron show a similar falling off.

A NEW Process for Welding which makes use of the heat generated by friction, is announced as having been practically put in operation at Chicago, a company having been organized there to develop it. Annealing as well as welding is performed by simple friction. Whatever may be the ultimate economy reached by the process, the statements relative to the industrial applications in which it has been found useful are so plausible as to compel a belief that an important addition to mechanical resources has been gained. The pieces to be welded together are rotated in a lathe, the ends to be joined being at the same time pressed into a die which gives the required shape at the junction. The movement of the pieces under pressure heats them rapidly to the welding temperature. It is not stated, so far as the writer has seen, whether any flux is required or not, but the inference would seem to be that no flux is needed. However, during the heating, the exposed surfaces which are to be joined can scarcely fail to have some oxide formed on them, the removal of which would appear to require the ordinary sand flux in order to get the perfect union claimed to be obtained by the process. It may be that a preliminary shaping of the ends to be joined, in a manner analogous to that employed in electric welding, obviates the necessity of a flux, the scale of oxide being forced outward as the ends are brought together. It is stated that copper and brass may be welded as well as iron, and that the operation of joining is exceedingly rapid; rods and tubes being welded in ten seconds. If all the claims for the process can be substantiated, there can be no doubt of its value. It is asserted that the U. S. Government has been investigating the process with a view to applying it to the manufacture of brass shells for dynamite guns, under the hope that in it may be found the solution of a difficulty hitherto met with in the final and tight closing of these shells at the end.

The Extraction of Oil from Cotton Waste may in many kinds of business be very profitably performed, saving both the waste and the oily material. This economy has been made the subject of a recent patent, or, rather, a patented apparatus for the purpose in England. The waste is placed in a perforated cage provided with a presser, which is either single or double acting, and capable of a reciprocating motion. A convenient form of double acting squeezer is a plate, movable upon a spindle fast to the bottom of the cage, and subjected to the power of a lever. A pawl on the plate engages with a rack and spindle, so that the pressure exerted primarily by the lever upon the plate is brought to bear upon the waste from opposite sides—say top and bottom—in the direction of the centre. The waste is then subjected to the action of an alkaline solution, which saponifies the grease. The latter, as well the dirt, are expressed by the operation of the presser. The presser is next raised, and a flush of water turned on. This flush has the effect of completing the extraction as well as removing all alkali. The presser is again raised, and a further flush of water

applied for the purpose of washing the waste. This operation of cleaning the waste is very rapid. The saponified grease is saved. The excess of alkali can be used over again after being fortified with fresh alkali, and finally, the waste, after having been dried and shaken in a wire cage to soften it, is ready for use again.

Seamless Gold Plated Tubes are now made of longitudinally split tubes of base metal slipped into longitudinally split tubes of gold stock, the base metal being covered with a fluxing material and so arranged that the longitudinal slits shall not coincide in position. Heat is applied to the compound tube and the gold is fused to the base metal, the gold flowing into the longitudinal slits and filling them. The tube can now be drawn through a draw-plate to give any desired degree of attenuation to the gold covering.

The silvering of iron may now be easily accomplished by any one who can manage a simple electric battery, using a process patented in Austria. The article to be silvered is first entirely freed from acid by placing it in a pickle of hot chlorhydric acid. It is then placed in a solution of mercury nitrate and connected with the zinc pole of a Bunsen element, gas carbon or platinum serving as the other pole. It is rapidly covered with a layer of quicksilver, when it is removed, washed and transferred to a silver bath and silvered. By heating to 300° C. (572° F.) the mercury is driven off, and the silver firmly fixed on the iron. To save silver the ware can be first covered with a layer of tin; one part of cream tartar is dissolved in eight parts of boiling water, and one or more tin anodes are joined with the carbon pole of a Bunsen element. The zinc pole communicates with a well-cleaned piece of copper, and the battery is made to act till enough tin has deposited on the copper, when this is taken out and the ironware put in its place. The ware thus covered with tin chemically pure, and silvered, is much cheaper than any other silvered metals. The process is available for a great variety of small articles.

A Rough and Ready Dynamometer for Small Motors was described by Mr. John Hoskin at a meeting of the Electrical Section of the Franklin Institute held May 5th. A leather belt with a spring balance attached to one end and a suitable weight at the other comprises the entire apparatus. As described by Mr. Hoskin the apparatus is used by throwing the belt over the pulley of the motor, the spring balance being fastened to the floor base or support of the motor to be tested, and the weighted end hanging pendent. When the motor is at rest the strain of the weight is read off on the spring balance. As soon as the motor runs at speed its tendency will be to lift the weight and the spring balance will be to that extent relieved from tension. The difference between the indication of the spring balance when the motor is at rest and its indication when the motor is running, multiplied by the circumference of the pulley, will give the foot-pounds of work performed at each revolution. This multiplied by the number of revolutions per minute and divided by 33,000 will give the result in horse power. Mr. Hoskin described this dynamometer with reference to its use for electric motors, but it will be obvious that it is equally applicable to any other small machine, such as air pumping engines, gas motors, etc.

Ammonia as a Source of Motive Power has long been considered feasible. Attempts were made years ago to utilize its expansive force as generated by heat from the exhaust steam of steam-engines. These efforts have however, owing to the then unmanageable character of the material, failed to reach any notable measure of success. Every day, however, adds to mechanical and engineering resources. The use of ammonia ice machines, has taught the mechanical and engineering world a great deal about practical methods of handling this material, the expansive force of which increases with such rapidity under increments of temperature, that much difficulty was formerly experienced in confining it and regulating the temperature with such accuracy as to prevent sudden rises of pressure. During the past month, however,

an experiment has been made in New York Harbor, which seems to demonstrate that the use of this material as a generator of motive power is hereafter to be considered within the possibilities, and perhaps even the probabilities. A tug-boat (the *Edwin D. Hartley*) has been fitted with appliances under patents owned by the Campbell Engine Company at the ship-yard of J. H. Dialogue, Philadelphia, under the direction of William B. Reaney, a Philadelphia engineer. The motive power is generated from a dilute solution of ammonia in water, made by mixing 85 parts of water with 15 parts of the ordinary aqua ammonia. The vapor or steam of this mixture is used in a steam-engine cylinder in a manner precisely analogous to the use of steam expansively. It is reported that this tug has been run by ammonia since the first of April of the present year, and that the results have been entirely satisfactory, showing a saving of 37% of fuel as compared with the fuel required for generating the same power with steam. It is further reported that a company under the name of the Inland Marine Company, has recently been organized, and will soon begin the construction of boats to be propelled by this new method.

The New Westinghouse Compound Engine Governor is an extremely ingenious piece of mechanism. Like the Westinghouse engine it is a new departure. At first glance it might appear to resemble to a considerable extent the governor used on the Armington & Sims high speed engines. The feature of its action which will at once attract attention is its power of rapid adjustment under instantaneous load changes; so small a change that it may be considered to be almost a differential of speed is sufficient to effect a change of position to suit the load by virtue of the force of inertia. Some cards taken from an engine to which this govenor has been applied at the Federal Street and Pleasant Valley Electric Railway Company in Allegheny City, Pa., are very remarkable. A variation of 250 H. P. in less than 3 seconds, or a rate of change of about 87 H. P. per second, was the test to which the governor was submitted. The diagrams indicate a wonderful efficiency in the control of the engine under these circumstances.

Manganese bronze is an alloy which has largely come into use for the manufacturing of propeller blades, and the properties of this alloy which can be forged, rolled and hammered, both hot and cold, would seem to adapt it to many other useful purposes. In a recent lecture before the Franklin Institute Mr. F. Linwood Garrison describes this alloy as a material which when cast in sand has an average elastic limit of 30,000 pounds per square inch, tensile strength of about 60,000 pounds per square inch with an elongation of eight to ten per cent. When rolled the elastic limit is about 80,000 pounds per square inch, tensile strength 95,000 to 106,000 pounds per square inch, and elongation, twelve to fifteen per cent. He adds that though "these results are obviously excellent it is hardly to be expected that they could be uniformly obtained, as in ordinary everyday foundry practice sufficient care is not taken to obtain the very best results. They show us, however, that much may be expected of this alloy, and that aluminum bronze is not the only copper alloy which will give us over 100,000 pounds per square inch in tensile strength."

Photo-Mechanical Prints, according to a Russian Process recently published, may, it is said, be made with an ordinary copying press. The details of the process are as follows: A sheet of glass is coated with bi-chromated gelatine which is developed and left to dry at ordinary temperature for 24 hours. It is then flooded with a solution made with water 100 c. c., glycerine 200 c. c., and the ordinary hyposulphite of the photographers 2 grammes, and according to the desired relief, the solution is allowed to act upon the bi-chromated gelatine from one to two hours. The plate is then dried by means of a soft pad and blotting paper. It is then ready for the ink, which is the ordinary printer's ink. The first two or three impressions will be bad, or until the dampness of the gelatine coating has been absorbed. The subsequent impressions are said to be excellent. The plates are laid in the copying

press upon a basis of India rubber cloth with a mask of paraffine paper. The paper on which the impression is to be made is then laid on and over it is placed a pad made with fine cloth filled with cotton wadding. This pad enables the paper to be brought by the press into contact with the plate in all parts. After about twenty impressions, the high lights may begin to show grey. Then the plate is dampened with a pad dipped in a solution above described, and after two or three impressions, which dry it, the impressions are said to be equal to the original ones.

One of the Latest Inventions is an Electric Fishing Apparatus. An electric fishing bob is so arranged that the fish even rash enough to nibble is so paralyzed by a shock immediately administered to him, that he floats upon the surface, and may be secured by an ordinary landing net. The line is a flexible wire insulated with rubber, and the hook is also insulated except a small section near the bob. This invention would seem to put all fishermen upon a level, as the sum of the skill required is simply the manipulation of the scoop net by which the fish is taken from the water. The pole may be placed in a fixed position, and the hook simply baited or arranged to attract the fish.

The Handling of Coal by Steam Power at the new stocking ground of the Lehigh Valley Railway Company at South Plainfield, N. J., was inititated on the 15th of July. On this occasion a 30-ton car was discharged in 8 minutes by green hands. The storage capacity of the company's grounds at that point is stated to be 310,000 tons, and it is also stated that an increase of storage capacity to 1,000,000 tons will probably be made.

A Very Ingenious Arrangement of a Portable Shower Bath is described and illustrated in *Les Inventions Nouvelles*. It consists simply in a water bellows from which rises a vertical pipe bent at the top in the form of a goose neck, and provided at its extremity with an ordinary rose sprinkler. A funnel in the top suffices for filling the bellows with water, the hydrostatic pressure expanding the bellows until they are filled. When this is done the funnel opening is tightly closed. The bather then steps upon the top of the bellows; his weight forces the water up the tube, out at the raised nozzle, and in this manner an excellent shower bath may be obtained. When not in use the pipe may be detached and the whole apparatus folded in a very convenient and portable form.

An Electric Riveting Apparatus was the subject of a recent American patent granted to Mr. E. E. Ries of Baltimore, Md. The device is a very ingenious application of electricity as an aid in the performance of this mechanical operation. The riveting is done by a system of toggle levers operated by a steam piston, but the heating of the rivet after its insertion is done *in situ*. The electric current being passed through the rivet it is heated to a red heat, and the impression being applied, the rivet is finished in this manner. The dies are so arranged that any desirable shape may be given to the rivet-head.

A Very Useful Suggestion to Mechanical Establishments is made by *Fire and Water*. That journal proposes that a gallon pail be filled with fine sand and placed within convenient reach of each workman employed where oiling and finishing is being done in wood-working establishments. As fire occurs very frequently by the ignition of oily wastes in machine shops, pipe-fitting establishments, etc., and as sand thrown upon an oil-fed fire is one of the most effective means of immediately squelching it, the suggestion is valuable.

Some Ingenious Experiments with a Screw Bolt were described in a paper by James McBride, presented at the Provi dence meeting of the American Society of Mechanical Engineers. Mr. McBride in his paper calls attention to the very meagre data existing with reference to the amount of power which is lost in the use of screws through their frictional resistance. Mr. McBride, in order to test the matter arranged nuts in such a manner as to support a 2-inch bolt upon which weights could be suspended, arranging the bolt so that it could not turn on its longitudinal axis. Taking the theoretical

value of a 2-inch bolt with a 22-inch pitch, Mr. McBride found that the weight which could be thus raised was only 10.19 per cent. of this value. The experiments were rough and not intended to give accurate data, but only to give approximately the amount of power utilized in the use of such a screw. A part of this suggestive paper is devoted to a review of such data as have been laid down by different authors, which he characterizes as being extremely indefinite; a statement which is well justified in reading the quotations which he has incorporated into his interesting discussion. All of these authors state that allowance must be made for friction. Some of them do not attempt to say how much, and others leave such a large margin of variation that what they do state is of little value.

An Extremely Neat Mechanical Dodge is described in a clipping taken from one of our exchanges, the source of which we are unable to give. It is a queer way of fastening a long bolt into a beam overhead where there was no chance of a nut and washer:

"The end of the bolt was drilled and countersunk as deeply as possible, when a hacksaw was used to split it into quarters lengthwise for a short distance by cutting two saw kerfs square across each other. A piece of iron about the shape of a rifle bullet was set in the countersunk hole, and the bolt driven into the beam. When it reached the full depth of the hole the iron piece came to a stop, when the four parts of the bolt were turned aside and got a firm hold in the fibres of the wood.

In the Solution of the Problem of Flying, Mr. Maxim is to find a competitor in M. Ader of Paris, who has constructed a large machine in which, it is stated, he has actually succeeded in rising to a height sufficient to clear the houses and has made a trip variously given as from 100 metres to 400 metres in the air. The machine is said to have cost the large sum of $120,000. According to statements made by the aeronaut himself as published in *Invention* (London):

"He first studied the resistance of air, and proposes to publish a treatise on his discoveries in what he calls 'Aero-Dynamic Science,' which he claims to have invented. He then watched the movements of some large eagles and vultures from the Jardin d'Acclimation which were lent to him by M. Barthélemy Saint-Hilaire, but deeming these observations insufficient and unsatisfactory, he started for Algeria in order to watch the flights of the cormorants—called charognards—which are similar to the birds nick-named adjutants in British India. He failed to find any of these wild fowl in the outskirts of Constantine, so he waited for the festival, during which the Arab women throw meat to the vultures, in order, as they say, to keep them from eating the dead bodies of the Sons of the Prophet killed in battle. Enveloped in a burnous, M. Ader went to Sidi M'sid, accompanied by two Arabs, who were to call the birds to him. His stratagem succeeded, and the vultures, timid at first, eventually came near enough to permit him to watch their motions of flight closely. He next built his apparatus, which is propelled by what he calls a combination of vapors."

"Kicked into a Fortune" is an expression applied to Mr. Maxim, the famous inventor, by an exchange, which states that his great invention of the rapid-firing gun was suggested to him by his personal experience in the recoil of a musket. We would rather put it that Mr. Maxim's fortune originated in his having the perceptive faculty to discern that this force, always exerted in the discharge of any firearm, was sufficient to actuate the mechanism which he so ingeniously applied in his great invention, It was not a "kick," but the brains to discover the value of a "kick," that made Mr. Maxim's fortune.

The Use of Molasses as Fuel is an innovation which is attracting notice. The very low price of molasses which has lately prevailed has induced the Louisiana planters to make experiments in this direction, in their sugar-house furnaces. The material is said to burn readily and develop a strong heat in combination with wood or wood fibre. The method so far seems to be that of sprinkling it on the bagasse and then feeding this to the furnace. The *Manufacturers' Record* estimates that the use of this material will supply fuel sufficient to manufacture all the sugar in Louisiana. This will certainly be a large economy, as prior to the utilization of molasses in this way, tens of thousands of gallons were emptied into the Mississippi River and Bayou Teche.

AN underestimate of Our Lake Commerce is charged against the Census Bureau by the *Marine Review*. This journal states that only one matter of importance has been attended to by the bureau, "the tonnage movement," and it claims that a failure has been made in this, asserting that "the figures on the coal movement fromLake Erie ports are grossly incorrect." The *Review* goes on to say that "the whole difficulty in collecting the lake statistics was based upon the action of Mr. Henry C. Adams, special agent in charge of the division on transportation, who burdened the vessel owners at the outset with a demand for answers to an endless amount of questions that could not be answered in one case out of a hundred. After all concerned had become thoroughly indignant, Mr. C. H. Keep, secretary of the Lake Carriers' Association, was called in to finish the work and he did the best he could under the circumstances. This last bulletin shows that on Dec. 31, 1889, the lakes have, exclusive of fishing craft, 2784 vessels of 924,472 gross tons and 780,119 net tons. These vessels are valued at only $48,809,750, notwithstanding the fact that Lloyds Inland Register, issued a few months later in the spring of 1890, contained the names of only 1974 vessels and they were valued at $50,200,800. The census bulletin attempts to explain this away by saying that insurance valuations are excessive." This plea is not regarded as sufficiently accounting for the discrepancy.

The Thermal Belt Electric Railway, a new road to be built between Rutherfordton and Asheville, N. C., is to thread three counties. The length of the road is to be 40 miles, and it is, we believe, the longest electric railway installation yet attempted in this country. The country which will be traversed by this road is through a picturesque region of rich mines and timber, whose scenery is said to possess great natural beauty. New York capitalists are said to be backing the enterprise from completion of which the town of Rutherfordton expects to benefit largely, as it will form a basis of supplies for the entire region traversed by the road. The construction and operation of 40 miles of electric railway would seem to be as good as 400 as demonstrating the feasibility of long electric railways.

An Electric Apparatus for Recording Votes has been recently made the subject of a communication to the Société d'Encouragement by M. Le Goaziou. The purpose of the apparatus is for the instantaneous counting and registering of votes in a parliamentary division. Rotating polechangers under the control of each voter who has at his desk or table two buttons at his disposal, enables him to record whether the vote is aye or no. If he wishes to abstain from voting he denotes this by pressing both buttons simultaneously. If neither button is pressed it denotes his absence from the house. The records therefore immediately show the positive and negative vote of the house on any question, together with those not present or being, present, not voting. This notice will bring to mind the apparatus for registering votes designed by Thomas Alva Edison, which was one of the first of

his electrical inventions. It will also be remembered by those who recollect the invention that its success was not encouraging. In fact Mr. Edison is said to have vowed upon the occasion that it would be the last invention that he would ever make unless he knew beforehand that there was an existing demand for it.

Business Morality seems at a low ebb abroad, as in the United States. We are getting accustomed to reading accounts of the defalcations of officers in banks and insurance companies, and of the derelictions of too confidently trusted agents in commercial establishments. Attempts to evade the payment of revenue duties are also common. We always hear about the unsuccessful ones. Those that succeed are of course concealed, concealment being the principal factor in the success of such endeavors. Early in July came news of a charge against the officers of the Bochumer Verein, one of the most extensive steel works in Germany, in substance that these officials have willingly permitted the forgery of inspectors' stamps and thus have been able to work off railroad material that had been officially condemned. The charge has been denied by the manager of the works, but that an establishment of this character could have even fallen under suspicion shows clearly that public authorities have to keep as sharp a lookout for frauds in Germany as they do in America.

A Significant Indication of Progress is the plan announced by Mr. George W. Parker, President and General Manager of the St. Louis, Alton and Terre Haute Railroad in his annual report. This plan is the division of profits with employés, which he says has long been the cherished desire of the management. As the road has not hitherto been able to make any dividends to stockholders, the accomplishment of the plan has been impossible. The report, however, states that it is hoped to realize funds by the sale of bonds received in payment for a part of the road recently sold, sufficient to put the stock on a paying basis, in which case the plan of profit-sharing will be immediately put into operation. It is confidently expected that the adoption of this plan will result in the prevention of all difficulties which might otherwise arise between the employés of the road and the officers of the Company and that no incentive to strikes will exist.

The Cost of Cable Roads as compared with those of electric roads has been shown in Bulletin No. 55 of the U. S. Census Bureau to be far in excess of the cost of the latter. The *Electric Railway Advertiser*, in an able editorial, reviews this document in which 50 railroads are compared, to wit, 10 cable roads, 10 electric roads, and 30 horse railroads, and in which the cost of road equipment, statistics of passengers and all the details of the cost of operation for each road are contained. This journal selects for comparison a cable road and an electric road, operating very nearly the same length of line, and proves by its figures that the electric road costs per mile less than one-tenth as much as the cable road. While it carried only about one-tenth as many passengers its profit per passenger was more than that of the cable road by nearly 30 per cent. The concluding paragraph of the editorial, which we quote entire, places these comparisons in a very strong light:

"Two things that stand out most prominently on a careful study of the statistics are these: That for equipments of similar capacity the electric roads cost enormously less than cable roads; and second, that for anything like equal amounts of traffic, with the same equipment, the electric road would flourish where a cable road would go into bankruptcy. It is, however, apparent that, unless there are still some undeveloped possibilities in steam for traction purposes, electricity is the street car motor of the future."

The Great Lake in the Colorado Desert proves to have been formed by an overflow of the Colorado River, and is simply an abnormal flooding of that region. Consequently it is to be regarded only as a temporary pond of large dimensions, and all the fuss and mystery that has been thrown around it has had little better foundation than the sensational reports of newspaper correspondents.

Septicæmia Caused by Poison from Hides recently resulted fatally in the case

of a porter employed by Messrs. L. F. Robertson & Sons, dealers in hides in New York City. The septic poison was conveyed by his hand to a small pimple on the cheek. The symptoms of septicæmia developed on the following day. He died on the fourth day thereafter. The case has directed attention anew to the danger of handling hides with unprotected hands. Rubber gloves serve to guard the hands when the skin is abraded, but they certainly cannot prevent the access of poison to other parts of the body where, as in the case cited, the poison may at any time be inadvertently conveyed.

The Ship Yards in Russia are all busily occupied in the construction of iron-clads and monitors. The immense cruiser *Ruric*, 10,000 tons burden and intended to have a speed of 20 knots an hour, is in process of construction at the Baltic Works. The *Novarino* of 9476 tons burden is also building at the Franko-Russian Works. A large iron corvette is building at the Nevsky Works. At the Pvotieloff Works two monitors, adapted for sea-going, are building. The entire number of ships of war at present in course of construction in the Russian ship-yards is said to be twenty-two.

It is stated that the American Indians want space for an exhibit at the World's Fair and that they are signing petitions addressed to the President of the United States and his cabinet to secure this permission. Petitions addressed to the Commissioners of the World's Fair praying for the same favor are also said to have been prepared. In these petitions it is set forth that the discovery of America was not only a momentous but a disastrous event to the aborigines of this continent, and that its celebration should not be passed without some recognition of this ancient race, in which, contrary to general opinion, greater advancement might be shown than is generally supposed.

The Profits in Recoining the Trade Dollar into Standard Silver Dollars are, on account of the difference in weights, theoretically 7½ grains of silver on each dollar recoined. It is found, however, that, as a matter of fact the, abrasion of the coins averages about 5 grains each, and thus the practical profits are reduced to no more than 2½ grain .

The Great Leary Log Raft which left St. John, New Brunswick, on June 28, arrived safely at New York, after the mishap which occurred in a storm off Bar Harbor. At that point the raft broke in two, and was, with some difficulty and danger, again joined together. The *Engineering News* points out the fact that nothing has been said of lights or signals on this raft, and raises the question what is to prevent the danger of a collision in case of fog by the great steamers whose paths are crossed by these rafts in their transit? That journal insists that some official supervision should be instituted as a precaution against such collisions.

The Roots of the Palmetto have been discovered by Prof. J. M. Picknell, Chemist of the Florida Experimental Station, to contain from 4 to 6 per cent. of tannin, which he believes available for tanning leather. It is said that the tannin is accompanied by glucose which is also a valuable property in tanning materials. In some instances the tannin is said to have reached 12 per cent. It is stated that a thorough investigation is to be immediately made in view of a probable important accession of tanning material to the manufacturers of leather.

An Investigation of the Phenomena of Lightning Shocks has been instituted by M. T. Evrard and M. L. Lambotte, the former being the chief engineer and director of the telegraph service in Belgium, and the latter a telegraphic engineer. These investigators have published several papers relating to their observations upon lightning shocks in and around Belgium. An important conclusion reached by them, if verified by further observations, is that a net-work of telephone and telegraph wires, such as is now almost universal in modern cities and towns, acts to greatly decrease the dangers of lightning stroke to buildings and structures. The Melsens lightning conductor is, according to these investigators, the best yet invented.

The *Elektricität Officielle Ausstellungszeitung* is the name of a publication to be

issued by order of the Board of Directors of the International Electrical Exhibition in Frankfort. It will be edited by Mr. Max Quarck and Mr. H. Massenbach. It is to contain reports of everything of interest relating to the Electro-Technical Exhibition and is expected, before it is discontinued, to form a complete history of the origin and course of the Exposition, and to contain a complete representation of the present state and prospects of electro-technics, with authentic reports of the professional congresses which are to be held during the Exhibition and reports of juries and discussions of the exhibits. It is also to contain original papers, detailed reports and notices. It will be illustrated by engravings, sketches and plans. The publication commenced on the 15th of April, and is expected to be continued for about 30 weekly issues. The name of this publication is to the English reader more imposing than euphonious.

A Vindication of the Weather Prognostications of the Signal Service Bureau, against the statements made by Judge Hammond, of Detroit, in a case tried last March, and in which a claim for damages was made by the owners of the schooner *Midnight* against the propeller *Wilhelm*, has been presented by Prof. Harrington, of Ann Arbor, Mich., in the *Meteorological Journal*. In this trial a question of the state of the weather depended in part on evidence derived from the Signal Service reports. Judge Hammond, on this occasion, intimated that the modern Signal Service observations were entirely unreliable, and reflected upon the observer whose business it was to prognosticate the storm which had a bearing on the case. The judge's remarks were extremely severe and were considered somewhat offensive. In refutation of Judge Hammond Prof. Harrington asserts that the weather, temperature and wind from July, 1887, to January, 1891, was correctly predicted 5 times in 6 at all stations in the United States. The temperature predicted was verified 3 times out of 4, and the cautionary signals 2 times out of 3. An interesting point brought out by Prof. Harrington is, that the verifications of predictions in summer lose 10 per cent. as compared with other seasons of the year. Still another peculiarity is, that the verifications on the Pacific Coast are much higher than those in the Lake regions, being 84 per cent. as compared with 77 per cent. He thinks that this is partly accounted for by the facts that the northern boundary around and west of the Great Lakes is a critical line across which weather conditions frequently pass, and that the predictions for the Lakes depend somewhat upon the Canadian weather service.

The Numerous Large Fortunes acquired by Electrical Inventors, has been noticed in an article contributed to the St. Louis *Globe Democrat* by its New York correspondent. The recent meeting of the American Institute of Electrical Engineers in this city called attention to this fact. Among the members of the Institute are Messrs. Alexander Graham Bell, Edison, Elihu Thomson, Frank J. Sprague, Edward Weston, J. P. Caton, George W. Stackley, Charles S. Haskins and Franklin L. Pope. All of these gentleman have made fortunes, and some of them very large fortunes out of their inventions. Edison is now considered to be a millionaire, and the smallest sum which any of these inventors have made is $150,000. Some twenty years ago the writer, in an article contributed to another journal, predicted that electric engineering would come to be a special profession, and that very large fortunes would be made in it.

Artistic Instruction has been denied women by the *Conseil Supérieur des Beaux-Arts*, Paris. In view of the facts that one of the buildings at the Chicago Exposition is the skillful design of a woman, and that all its details of construction have been worked out by her, this action is to be regretted. The Institution named, in promulgating its denial, recognized, however, that women had equal rights with men to artistic instruction; but stated as the reason for the denial that, with the existing buildings and present regulations, it would be difficult to sufficiently regard social *convenances*. Another reason assigned was, that if a too

easy access to the National School were permitted to women, an advantage would be taken of this teaching by those whose want of natural talent would preclude any excellence of attainment in the higher paths of art. The Institution would therefore be degraded to a school for imparting merely sufficient knowledge to assist pupils to attain a living as decorative designers.

A New Military Telegraphic Apparatus for Field Service has been devised by an inventor in Plymouth, England. He calls it the Combination Military Telegraphic Field Sounder. In noticing this invention the foreign electric papers consider it as having advantages over apparatuses at present in use on account of the fact that it is not so bulky and that in the latter the sounder, key, batteries and drum for coiling the wire, are separate and distinct from each other, and require considerable time to adjust them into working order. There is also the danger of mislaying or losing during the haste and confusion of field operations. The new apparatus may be adjusted for use in a very short time. It is, moreover, easily conveyed from one point to another, and the wire may be paid out as the operator goes to his position on the field. Having arrived at the spot for receiving and transmitting messages, which may be anywhere within two or three miles from his first station, he has simply to set down his apparatus on a tripod upon his desk, make his wire connections and he is ready for operations. Messages may also be received by telephone whenever there is any diminution of the current from the sending point. The entire apparatus is so compact that it may all be folded, including the tripod stand, into a space so small as to be easily carried in a knapsack. For telephonic purposes a tube and ear piece is affixed to the ear by means of a rubber band so as to convey sound to the operator and exclude the exterior sounds of firing, etc.

The Effect of the McKinley Tariff on Trade in Sheffield, England, is said by *Engineering*, London, to realize the worst fears which have been entertained regarding the operation of the Act on the cutlery trade. During the last three months cutlery has been exported to the United States only to the value of £21,666. This is the lowest total yet reached, being £1300 less than the amount in the first quarter of the year, when the exports were even then unprecedentedly low. "In April the value of cutlery exported to the States was only £4661; in May it was £7515, and in June £9489, making a total of £21,666 1s. 11d. In the corresponding quarter of 1890 the value was £81,245, but this is scarcely a fair comparison, seeing that a year ago merchants, at the urgent call of their American agents, were despatching the largest possible amount of goods to get them safely through the Custom House before the imposition of the higher duties. A juster comparison would be with the second quarter of 1889, when cutlery was exported to the value of £58,807 18s. 7½d, or the same quarter of 1888, when the value was £50,335. Regarded, therefore, in the most favorable light, there is a falling off of considerably over 50 per cent. The value of steel exported also shows a decline, but to nothing like the same extent. Last quarter the value was £68,302 7s. 6½, as compared with £87,288 twelve months ago."

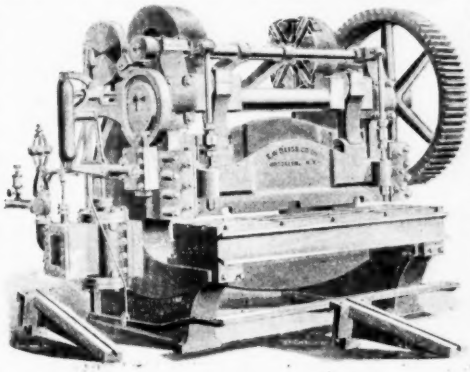
Sulphate of Copper has begun to be largely used in European vine culture as a preventive against phylloxera, peronospera and other insects, and, as was the case with Paris green in this country when it was found to be a remedy against the ravages of the potato bugs, a large horticultural market is likely to be opened for this substance. An exchange points out that copper sulphate can be produced from matte very cheaply by the wet processes suitable for extracting the gold and silver contents. This has hitherto been a mere by-product, and if the expected demand for its use be realized it may effect a considerable modification in the metallurgy of copper. From French and Italian publications it would seem to be indicated that a large amount of the salt will be absorbed for the purposes named.

Rails Recently Ordered of an English Firm for Egypt, 2000 tons, sold at £4 18s. 6d. per ton delivered at Alexandria.

NEW MECHANICAL APPLIANCES.

NEW STEAM PLATE SHEAR.—The E. W. Bliss Co. (limited), Brooklyn, N. Y., have a new steam shear for cutting ¾-inch plate, which possesses some new features, the principal one of which is the device used for stopping and starting the machine. An illustration accompanies this.

Heretofore shears of this character have been supplied with a clutch on the main crank shaft, on which latter, when the clutch is in operation, the driving gear runs loose. The improvement consists in keying this gear rigidly to the crank shaft and placing a friction clutch upon the pinion or fast speed shaft. The shafting bar operating this clutch is connected with a lever and counterweight, shown at the left-hand side of cut. On the main crank shaft is a cam operating a slide working in vertical guides upon the housing. The mechanism is so arranged that when the cranks are in their upper position, so that the shear knives are open to receive the work, a latch in the slide acts to raise the counterweight and hold the friction clutch out of gear, thus allowing the cutter bar to stand at rest. Depressing the treadle throws the latch out of gear, allowing the weight to drop, which action throws the clutch into operation and starts the machine. When the crank shaft has made one revolution the cam above referred to depresses the slide, thus lifting the counterweight and stopping the machine. As these motions are very easy there is no shock or jar in starting, which is the case where a positive clutch is attached to the main gear, and as the train of gearing is at rest when the cutter bar is not moving, the shaft is held securely with the cranks at their top centre, with no tendency to drop back or ahead, even though no counterweight is used to balance the cutter bar.



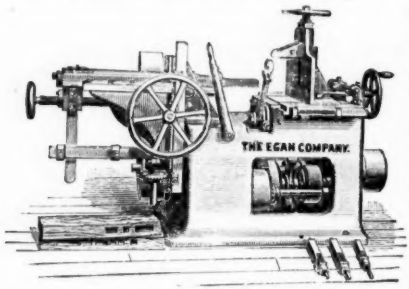
The cutting blades are 8 feet 4 inches long, and there is sufficient gap in the housings to allow of a plate 36 inches wide being split through the centre. Immediately in front of the cutter bar is a clamping bar, which, when the machine is started, automatically descends and securely holds the work in place while the shearing is taking place. The machine is geared about twenty to one, and is driven by a plain slide valve engine 12″x 15″ which is attached directly to the housing. The crank shaft is of hammered steel, with cranks forged solid and slotted out.

In order to compensate for wear of the blades, the lower one is supported on a long wedge by setting up which, the cutting edge of the blade is kept level with the table. The upper blade is adjusted downward by lowering the cutter bar bodily. The machine weighs about 45,000 pounds.

A Power Hack Saw that has commanded our attention, is manufactured by The Millers Falls Company, and may be seen at their establishment, 93 Reade Street, New York. This simple, yet extremely effective, machine comprises a stout cast-iron frame with a bed plate supporting the driving pulley and a clamping device for holding the work steadily under the operation of the saw. The saw is driven at the rate of forty strokes per minute by

the pulley and an intermediate pitman. The saw is weighted to give the proper pressure. The manufacturers state these saws will do ten times as much work as can be done by hand, a single saw blade sufficing to cut off several times a shaft 5 in. in diameter.

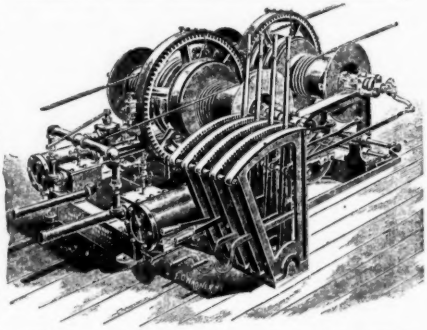
IMPROVED AUTOMATIC SQUARE CHISEL CAR MORTISER AND BORER.—The Egan Company, of Cincinnati, offers an improved Automatic Square Chisel Car Mortiser and Borer, which effects material saving in



time and labor. The machine as shown in the accompanying cut is thus described by the builders:

It is especially designed for, and capable of cutting the heaviest mortises in hard or soft wood, from ⅛″ to 9″ deep, leaving each mortise entirely free from chips. It will also make end tenons, gain or mortise clear through a 9″ timber, also countersink for bolt heads. Its high efficiency and adaptability to the work for which it is intended and the great variety of work which can be accomplished with it at one handling of the timber, makes it one of the greatest time and labor-saving machines of this class ever brought forward. The column is one entire casting cored out at the centre, strongly braced and thoroughly able to withstand any strain or shock that may be given it. All working parts are planed perfectly true and in line with each other. The bed rests on the main column, held in position by gibs; the cross movement being controlled by a friction clutch provided with stops to gauge the length of mortise. The upper part of the bed which holds the timber has an extra movement operated by a hand-wheel and screw to gauge the depth of mortise. All other makes of this style of machine have a stationary bed, and the depth of mortise is made by blocking up behind the timber that is being mortised. The chisel mandrel is driven by a new improved friction and gearing, with a quick return, and raised and lowered by rack and pinion. There are suitable stops provided for gauging the travel of the slide, also a regulating screw for changing the position of the chisel to suit the work. The machine will take in stock up to 16″ wide and 14″ deep, and cut a gain at the top of a 12″ timber. If necessary, an extra boring attachment can be fitted to the machine for boring joint bolt holes, side sills and general work.

MUNDY'S FOUR DRUM ENGINE.—The patent friction four drum Engine shown in the engraving is one of the new designs that J. S. Mundy, Newark, N. J., has added to his long list of hoisting engines. This one is so constructed that all four drums are operated by one man, and four derricks are now being used with them in the yards of the Berlin Iron Bridge Co., at East Berlin, Conn., hoisting bridge iron, etc The Engines are double cylinder, 7″ bore and 12″ stroke, and are 10 horse power each, total, 20 horse power. The friction drums are operated by the four top levers and when thrown into clutch, are held by the ratchets as shown. The four lower levers are connected to the brake bands,



and, when pushed down, draw the bands tight around the friction drum head, and are also held by a ratchet. When the top lever connected to the friction is released, the brake band holds the load while the engineer is hoisting another by a different derrick, so operating four derricks.

EDITOR'S EXCHANGE TABLE.

ILLUSTRATED articles are indicated by an asterisk (*), continued articles by a dagger (†), and concluded articles by a double dagger (‡). Orders for copies of the publications mentioned should be sent direct to the addresses given.

ENGINEERING. *w.* 6d. London. JUNE 19. "Electric Lighting in Chicago."* "The Atlantic Records—The Performances of Present Day Racers Compared." "The St. Louis Merchants' Bridge."*‡ "Torpedo Boats for the Argentine Government." "Petroleum Engines at the Doncaster Show."* "The Faraday Centenary." "The Columbian Exposition of 1893." "The Frankfort Electrical Exhibition."*† JUNE 26. "Water-Tight Bulkheads in Ships." "Sounding Machines—Deep Sea and Other." "A Five Day Transatlantic Steamer."* "Marine Engineering Practice Forty Years Ago." JULY 3. "Examples of the Comparison of Steamers and Yachts."* "Portable Electric Lighting Plant."* "30 Horse Power Four Cylinder Gas Engine."* "Installation of Torrent Filters."* "The Betaloo Concrete Dam."* JULY 10. "The Comparative Cost of Gas and Electricity." "The Supremacy of the British Mercantile Fleet." "An Early Dinamo."*

GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE. New York. JULY. $2 per year. "Geographical Progress in England." *J. Scott Keltie.* "Does He Resemble an Ape?"* "Kiepert's Map of Asia Minor." "Scientific Work in Honduras." "Tea Planting in Ceylon." *David Kerr.* "Geographical Poetry." "Cannibals." *Cyrus C. Adams.* "Lake Bonneville." *Ralph H. Tarr.* "Africa's Best Native Ruler."* "The Railroad Development of South America." *Courtenay DeKalb.* "A Woman's Explorations." "The Muata Yamvo." "Wrongs of the Zulus." "Enlightening the Dark Places." "The City of Toronto."* *J. H. Taylor.* "Recent Exploration in Africa." "Completing the Exploration of Australia." "Mr. Peary's Expedition." "Mountain Climbing." "The Boy Traveller." "J. Scott Keltie."* "White Women in Arctic Regions." "The Cañons of the Colorado." "An Interesting Question Solved." "The Sponge Industry." "Climate Conditions in the Glacial Age."

DISCOVERY. *m.* 3d. Liverpool. JULY 1. "The Extraction of Aluminum by Electricity." "Feathering Propellers."* "Mounting Photographs." "The Future of Breadstuffs." "Kola Nut." The Manufacture of Olive Oil in Persia." "The Hemp Industry of the Phillipines." "Transporter for Excavated Material on the Manchester Ship Canal."*

LOCOMOTIVE FIREMEN'S MAGAZINE. *m.* $1 per year. Terre Haute. JULY. "The Accumulation and Distribution of Wealth." "The Social Chasm." "An American Aristocracy." "Carnegie as a Squeezing Philanthropist." "The Single Tax." *Charles Marshall.* "Competition of Labor." *W. S. Carter.* "Charity Organizations." *Charles Danforth.* "Labor and the Single Tax."‡ *B. C. Stickney.* "The Liquor Traffic as a Cause of Poverty." *F. R. Dana.*

LOCOMOTIVE ENGINEER. *w.* 10c. New York. JULY. "Machine for Attaching Air Hose Fittings."* "Locomotive Running Repairs."* *L. C. Hitchcock.* "Progressive Examination of Locomotive Engineers and Firemen." *John A. Hill.* "The Master Mechanics Association." "Some Notes of the Southern Pacific and Central Pacific Shops."* "Some Improved Attachments for Bolt Heading and Spike Machines."* "Magnitude of Car Repair and Interchange." "Business in Chicago."

THE ELECTRICIAN. *w.* 4d. London. JUNE 19. "Mayor and Coulson's Method of Concentric Wiring." "The Faraday Centenary."* "Telegraphic Communication with Lighthouses." "Electric and Magnetic Theories." *John T. Sprague.*† "The Electrical Manufacture of Phosphorus." "The Caustic Soda and Chlorine Syndicate." "The Faraday Centenary." "A Study of the Planté Lead—Sulphuric Acid—Lead Peroxide Cell, from a Chemical Standpoint." In two parts; part I, by *G. H. Robertson;* part II, by *H. E. Armstrong, F. R. S.,* and *G. H. Robertson.* "On Electrical Evaporation."* *William Crookes, F. R. S.* JUNE 26. "The Historical Development of the Induction Coil and Transformer."*† *Dr. J. A. Fleming, M. A.* "The Electro-Magnet in Eye Surgery."* *Sylvanus P. Thompson, D. Sc., F. R. S.;* and *J.*

Tatham Thompson, M. B., C. M. "A Clock for Pointing out the Direction of the Earth's Orbital Motion in the Ether."* *Prof. O. Lodge, F. R. S.* "Electric and Magnetic Theories."‡ *John T. Sprague.* "Electrical Instrument Making."*†

ELECTRICAL PLANT. *w.* 6d. London. JULY 1. "Electric Lighting in Italy."*† "The Electric Lighting of Public Buildings."† *Prof. Jamieson, M. Inst. C. E., F. R. S. E.* "Electrolysis as Applied to Metallurgy."† "Electric Night Lights for Ordnance."*

MINING AND SCIENTIFIC REVIEW. *w.* $2 per year. Denver. JULY 2. "Manufacture of Slag Brick in Montana." *Thomas Egleston, Ph. D.* "The Great National Question—The Free Coinage of Silver."

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